SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY, 1926.

GENERAL PHYSICS.

1487. *Density and Molecular Diameter of a Fluid.* **J. H. Shaxby.** (Comptes Rendus, 182. pp. 847–849, March 29, 1926.)—The theory adopted is that the density of a fluid is determined by an equilibrium between inter-molecular attraction and thermal tendency to dilatation. This equilibrium determines an equation $p = \rho_0 . \epsilon^{-V/RT}$, where V is the molecular potential energy and ρ_0 the density in the most crowded condition (potential energy = 0). V is itself a function of ρ; $V = E_0 - B\rho^{1/3}$, E_0 and B being specific constants for the fluid; E_0 is the characteristic molecular energy. If T_c and ρ_c be the critical temperature and pressure, then, assuming that at the critical temperature the kinetic energy (thermal) is equal to the potential energy (inter-molecular), we have

$$\rho^{1/3} - \rho_c^{1/3}(T/T_c) \log_e (3/2\rho_c^{1/3}) = 3/2\rho_c^{1/3} - \rho_c^{1/3}(T/T_c) \log_e (\epsilon^{1/2} . \rho_0^{1/3}),$$

which verifies well for fluids, less well for saturated vapours. From this it follows that $E_0 = 9/2RT_c$, three times the thermal kinetic energy at the critical temperature. Also, if 1 refer to the liquid and 2 to the saturated vapour, we have $V_2 - V_1 = RT \log_e (\rho_1/\rho_2)$; note that the latent heat of evaporation, L, otherwise is $(1 \cdot 7$ to $2 \cdot 0) RT \log_e (\rho_1/\rho_2)$. Also, $L = K(\rho_1^{1/3} - \rho_2^{1/3})$, the same expression as was obtained by J. E. Mills [Abstract 2062 (1902)] on the impossible hypothesis that intermolecular attractions followed a law of inverse squares; the present deduction is independent of the law of attraction. If M be the molecular weight, N the Avogadro number, σ the molecular diameter, we have $M/N = \rho_0 \cdot \sigma^3$, whence $\sigma = e^{-1/2}(M/N\rho_c)^{1/3}$. This gives results which agree well with those obtained from viscosity under the kinetic theory, except for hydrogen and helium. A. D.

1488. *Gas Density Determinations with the Displacement Balance.* **A. Stock** and **G. Ritter.** (Zeits. phys. Chem. 119. pp. 333–367, March 25, 1926.)—In this paper two types of micro-balance are described: (1) Simple displacement balances for the ordinary operations of analytical and preparative chemistry whereby the density of a few c.c. of gas can be rapidly determined within 1 %; (2) very accurate instruments giving results within 0·01 %. A section is devoted at the outset to a general but very comprehensive discussion of the balance itself, its manifold sources of error and their elimination, and the influence of temperature. Following this comes a detailed description of a simple balance constructed of glass with illustrations and specimen density determination data for carbon dioxide compared with air, mixtures of carbon dioxide and air, and for the molecular weight evaluation of boron hydride B_5H_9. Sections then deal with simple balances furnished with magnetic null-point adjustments which have proved exceedingly serviceable for diminutive amounts of unstable volatile substances, accurate quartz instruments with and without magnetic adjustments, and estimations conducted entirely under magnetic control. A large final section is devoted to practical technique concerned with the construction of the instruments. The thirty-four pages of the paper are so packed with valuable detail as to merit being consulted in their entirety. H. H. Ho.

1489. *Condensation Pump Acting on Medium Primary Vacua.* **L. Dunoyer.** (Comptes Rendus, 182. pp. 686–688, March 15, 1926. J. de Physique et le Radium, 7. pp. 69–75, March, 1926.)—The pump described is designed to operate on vacua of from 10 mm. to 30 mm. Hg and to be of minimum cost and fragility. It is constructed entirely of glass, and high vacuum is produced in two stages, the mercury-vapour passing through a sloping injector nozzle into a water-cooled space connected with the primary vacuum providing the first stage. Small perforations in the upper end of the same nozzle opening into a concentrically disposed outer tube surrounded in turn by a water-cooled space connected with the high vacuum provide the second stage. Vertical tubes lead the condensed mercury-vapour produced at each stage back to the boiling bulb. No special claim is made for the *speed* of operation of this pump as compared with other condensation pumps. A. B. C. L.

1490. *Some Physical and Optical Characteristics of the Stylus-on-Celluloid Method of Recording.* **W. G. Collins.** (Optical Soc., Trans. 27. 3. pp. 215–218, 1925–1926.)—It is shown that the stylus-on-celluloid record consists of a cylindrical depression forming a minute cylindrical lens, bordered by ridges forming quasi-cylindrical lenses of positive form and beyond these concave cylinders. When viewed with a properly focussed microscope, the record appears as a dark band on a bright ground, and at the centre of the dark band is a fine bright line on which precise measurements can be made. The record is not made by scratching but by plastic deformation. AUTHOR.

1491. *Quantitative Measurement of Quick Changes in the Outflow of Liquids.* **G. V. Anrep and A. C. Downing.** (Journ. Sci. Instruments, 3. pp. 221–224, April, 1926.)—By means of a method involving the use of a fine hot wire, it is possible to determine very small and varying rates of flow of a fluid with great accuracy. The lag due to inertia of recording instruments is almost entirely eliminated. AUTHORS.

1492. *Equilibria in Systems in which Phases are separated by a Semi-Permeable Membrane. IV–XI.* **F. A. H. Schreinemakers.** (K. Akad. Amsterdam, Proc. 28. 2. pp. 157–173; 28. 3. pp. 231–251; 28. 4. pp. 396–402; 28. 5. pp. 480–498; 28. 6. pp. 564–572; 28. 8–9. pp. 812–820, 1925, *et seq.*)—A series of theoretical papers [see Abstract 1539 (1925)]. The osmotic behaviour of ternary liquid systems is discussed in which either

a solid binary compound or a solid ternary compound occurs, or more than one solid phase is possible. From the changes in the thermodynamic potentials accompanying the passage of small quantities of liquid through a membrane separating two systems, the osmotic water attractions of various systems are derived mathematically. Consideration of cases with one system composed solely of solids leads to the conclusion that all solutions capable of existing in equilibrium with a system of solid substances in which addition or withdrawal of the diffusing substance may lead to a phase reaction have identical osmotic water attractions and are isotonic. If two systems are in osmotic equilibrium with regard to a number (d) of diffusing substances, the osmotic attractions of the two for each of these substances are equal. If the first system consists of n_1 components in r_1 phases at pressure P_1 and the second of n_2 components in r_2 phases at pressure P_2, at constant temperature, the first will have $n_1 - r_1 + 1$ and the second $n_2 - r_2 + 1$ degrees of freedom. The total number must, however, be diminished by d, so that the number of degrees of freedom of the two systems in osmotic equilibrium will be $n_1 + n_2 - (r_1 + r_2) + 2 - d$. This is the membrane phase-rule, of which various cases are discussed. The character and action of the theoretical membrane assumed in the above considerations are discussed, and it is shown that the same considerations hold (1) for a real membrane with mass small compared with that of the ternary systems in question, and (2) if one of the separate systems consists of substances of constant composition between which a phase reaction occurs when water is introduced or withdrawn. The membrane phase-rule is applied to osmotic equilibria of two ternary systems separated by a semi-permeable membrane in the cases when the two systems contain one or two common components. The case of a number of systems with several semi-permeable membranes is also treated.
T. H. P.

1493. *Structure of Films of Water on Salt Solutions. II. Surface-tension of Calcium Chloride Solutions at 25°.* **W. D. Harkins** and **E. C. Gilbert.** (Am. Chem. Soc., J. 48. pp. 604–607, March, 1926.)—The results are given of measurements at 25° of the surface-tension of water and of aqueous calcium chloride solutions of concentrations up to 7 mols. of the salt per 1000 grammes of water. From the surface-tensions and the values of the activity coefficients for calcium chloride calculated from data found in the papers of various investigators, the mean thickness of the water film on the calcium chloride solutions is calculated [see Abstract 16 (1926)]. At the concentration 1·25 M the thickness of the film is 3·1 Å.U., which is the cube root of the volume of a water molecule. At lower concentrations the film is thicker and at higher concentrations thinner, but up to 3 or 4 M at least it is essentially a monomolecular film.
T. H. P.

1494. *Wave Demonstration.* **F. Schramm.** (Phys. Zeits. 27. pp. 224–226, April 15, 1926.)—Particulars are given of a machine used to demonstrate wave motion. Four cases are considered: (1) moving-waves, (2) an individual wave, (3) reflection at a denser medium, and (4) stationary waves. Figures are constructed to illustrate the sine-wave motion of individual particles, and these figures fixed to a glass cylinder which can be rotated about a horizontal axis. A narrow band of this cylinder is illuminated and an image of this band thrown on a screen for demonstration. The apparatus is considered simpler and possessing other advantages over the Weinhold arrangement for longitudinal waves. R. S. R.

1495. *On the "Hyperbola" Method for the Measurement of Surface-tensions.* **A. Ferguson and I. Vogel.** (Phys. Soc., Proc. 38. pp. 193–203; Disc., 203, April, 1926.)—When a liquid lies between two plates inclined to one another at a small angle its surface has a hyperbolic section, from measurement of which the surface-tension can be calculated. The method has long been known, but has recently been improved by Grünmach [see Abstract 1356 (1919)]. Errors arise, however, from the difficulty of determining the horizontal and vertical axes of coordinates, and according to the present paper this difficulty is met by plotting two linearly related functions of the observations, the surface-tension being deduced from the coordinates of the resulting mean straight line and the angle between the plates. The latter may be measured either directly or by calibration with a liquid of known surface-tension. AUTHORS.

1496. *Demonstration of Some Surface-tension Phenomena.* **E. Edser.** (Phys. Soc., Proc. 38. p. 274, April, 1926.)

1497. *The Surface-tension of Freshly-made Water Surfaces.* **F. Schmidt and H. Steyer.** (Ann. d. Physik, 79. 5. pp. 442–464, March 24, 1926.)—According to Lenard [Abstract 582 (1911)] water contains complex molecules $(H_2O)_n$, and the molecules of the smallest surface-tension accumulate on the surface. There should therefore be a diminution with time in the tension of freshly-made surfaces, quite apart from external contamination of the surface. The authors determine this rapid diminution by a modification of the capillary method of Hiss (dissert., Heidelberg, 1913). The water rises in a glass (or quartz) tube which is closed above (not drawn out), but fitted with a small circular opening through which the water escapes. A current of air blown across the top sprays the liquid andcontinuously renews the surface; the air-jet is suddenly stopped by means of an electromagnetic shutter. The surface-tension diminishes and the water column sinks during a small fraction of a second, until the surface has attained the ordinary static surface-tension of pure water which is found to be 7·395 mg./mm. at 18° in quartz tubes, in agreement with Lenard [wire-frame balance method, Abstract 2413 (1924)] and others. The maximum tension observed immediately after stopping the air-jet was nearly 10 mg./mm.; this maximum varied with the temperature of the water and air; at 4° and again at 36° the surface-tension had the ordinary static value mentioned. The diminution takes place within about 3×10^{-3} sec. The many possible sources of error, microscopic observation, cooling by evaporation of water and expansion of the air in the jet, water-spray electrification, etc., are discussed. H. B.

1498. *Further Demonstration of Surface-tension Phenomena.* **C. R. Darling.** (Phys. Soc., Proc. 38. pp. 275–276, April, 1926.)—Experiments relating to Burdon's paper [see Abstract 1198 (1926)] were shown. The spreading of pure water over mercury was shown to be the same as that of olive oil over water, the beaded edge and internal holes being present in both cases. The formation of holes after spreading was shown with a number of liquids on water. To illustrate a suggestion that changes after spreading are due to alterations in interfacial tension, a drop of quinoline was allowed to fall on a globule of light oil floating on water. On the quinoline reaching the junction of oil and water, the globule was violently shattered. It was suggested that when a drop of one liquid is placed on another, a thin (possibly monomolecular) layer spreads rapidly, but is unstable, and interfacial tension restores the stable lenticular shape. W. G. B.

1499. *The Viscosity of Soap Solutions.* **B. L. Clarke.** (K. Vetenskapsakad. Nobelinst., Medd. 6. 1. pp. 1–9, 1925. In English.)—At ordinary temperatures the viscosity of soap solutions of low concentrations increases with age up to a maximum which is reached after about two days and is followed by a gradual decrease which, in the limit, appears to be the same as would be obtained if the solution could be cooled instantaneously from the boiling-point to the temperature of the experiment and a reading taken. On boiling the solution the influence of ageing is eliminated, and at 100° C. no change of viscosity with age can be detected. Solutions can in this way be brought to give reproducible viscosity values. With higher concentrations no change of viscosity with age is obtained. Solutions exposed to the atmosphere undergo an increase in viscosity through interaction with carbon dioxide. The viscosity of aqueous solutions of sodium stearate and sodium oleate are measured at several temperatures over wide ranges of concentration, and determinations by Farrow on sodium palmitate are referred to. The palmitate and stearate are found to follow the Arrhenius formula $\log \frac{n}{n_0} = \theta C$, while less concordant values are given with sodium oleate. J. N. P.

1500. *Viscosity and Turbulence.* **C. Camichel, L. Escande** and **M. Ricaud.** (Comptes Rendus, 182. pp. 881–883, April 7, 1926.)—The kinematic coefficients of viscosity μ_1, μ_2 and μ_3 of petrol, water and a sugar solution in non-turbulent flow were determined by Poiseuille's method. Calling the ratios of these coefficients to the density of the liquid a_1, a_2 and a_3 the values of the two quantities $K_{21} = a_2/a_1$ and $K_{23} = a_2/a_3$ were calculated. The three liquids were then caused to flow in turn through the same tube with turbulent flow, the differences of pressure p_1, p_2 and p_3 between two points A and B and the velocities V_1, V_2 and V_3 being determined. It was found that the curves $(p_1K_{21}^2/\rho_1 g, V_1K_{21})$; $(p_2/\rho_2 g, V_2)$ and $(p_3K_{23}^2/\rho_3 g, V_3K_{23})$ were identical. Experiments were also made with tubes of irregular form, elbows and obstructions, and with a mixture of petrol and oil the viscosity of which was the same as that of water, and similar results to the above were obtained. In studying gyratory motion two geometrically similar cylinders were employed, the ratio between the dimensions λ being 8/3. The liquid was caused to whirl about the vertical axis and the times taken to empty the cylinders were measured; the ratio between these times was 1·61, while the theoretical ratio $\sqrt{\lambda} = \sqrt{8/3}$ was 1·63. H. N. A.

1501. *Adhesion Phenomenon in Capillary Tubes.* **C. Hagen.** (Phys. Zeits. 27. pp. 47–57, Jan. 15, 1926.)—The adhesion phenomenon familiar in the use of the Macleod gauge when the pressure is very low is here investigated for capillary tubes of varying diameters and the results expressed in the form of curves showing the relation between the gas-pressure and the length of adhering column. The effects of the shape of the vertex of the capillary, of gas occluded in the walls of the glass and given off at low pressure and of varying temperature are considered. Capillaries lined with sealing-wax give similar results, tubes of metals forming amalgams show it, though at far lower pressures than for glass, iron tubes do not show it at all. The phenomenon does not appear when Woods metal is substituted for mercury. The possibility of using this phenomenon for low-pressure determination is considered. G. A. S.

1502. *The Application of Radiography to the Study of Capillarity.* **E. A. Owen** and **A. F. Dufton.** (Phys. Soc., Proc. 38. pp. 204–205; Disc., 205–206, April, 1926.)—The X-ray shadow of a tube has previously been used for determining the diameter of the bore [see Abstract 376 (1924)]. The present investigation was designed to test the suitability of a similar method for capillarity measurements, and observations were made of the rise of mercury in copper and steel tubes and between vertical copper plates. The results were satisfactory. AUTHORS.

1503. *Lubrication.* **J. J. Trillat.** (Comptes Rendus, 182. pp. 843–846, March 29, 1926.)—Bragg's idea that lubrication is due to a laminated structure developed in the lubricant is confirmed by X-ray reflection spectra. The laminæ are two molecules thick in triglycerides, one molecule thick in saturated hydrocarbons. Fatty matters form a layer on the metal, on which layer hydrocarbon molecules slip easily. X-ray spectra may be used as a means of analysis of lubricant mixtures. A. D.

1504. *Vortical Motion in Univocal Correspondence with a Uniform Translation.* **B. Finzi.** (Accad. Lincei, Atti, 3. pp. 130–135, Feb. 7, 1926.)—In Accad. Lincei, Atti, 2. p. 407, 1925, the author had put the question, Is a spatial motion possible such that a simply infinite family of surfaces of flux-area σ may consist of isotach-surfaces, the motion on each σ being potential in the sense there specified? This question is now answered in the affirmative; the motion on each σ is precisely determined on our knowing the potential motion plane constituted by a simple rectilineal uniform translation. A. D.

1505. *Fluid circulating round Two Parallel Cylinders.* **F. Sbrana.** (Accad. Lincei, Atti, 3. pp. 136–139, Feb. 7, 1926.)—The results of Cisotti (*ibid.*, 1. p. 568, 1925) as to uniform circulation between two coaxial cylinders extended to the case where the outer cylinder surrounds two parallel cylinders. A. D.

1506. *Waves of Distortion in Heavy Media.* **K. Uller.** (Zeits. Math. u. Mechanik, 6. pp. 106–111, April, 1926.)—This is a mathematical paper in which the effect of a stationary field of force on the character of waves which are possible is discussed. The author finds that one of the possible waves assumes a singular form which is essentially determined by the field of force. Two waves of distortion are found to be possible in a heavy medium. These the author calls (1) a pure shear wave, and (2) an attenuation-shear wave (Verdünnungsscherungswelle). The nature of (1) is found to be independent of the field of force as well as of the volume elasticity and the volume viscosity. In the case of

(2) the field of force produces changes of volume and rotation accompanied by change of form. The effect of gravity on earthquake waves is shown to produce an effect of the type of (2), and a wave of this type must also be produced in a medium densely packed with electrons and magnetons. T. B.

1507. *Bending Strength of Curved Rods.* **T. Matsumura.** (Kyoto Coll. Eng., Mem. 4. pp. 1-20, Nov., 1925.)—The author first discusses the ordinary theory of the bending strength of curved rods, which he considers not to be free from some looseness, especially when the radius of curvature decreases relatively to the height of cross-section. The paper itself is then concerned with a modified theory wherein a differential equation is derived and applied to the particular cases of rectangular, trapezoidal, and circular sections. Numerical results from both theories are included for comparison purposes. H. H. Ho.

1508. *Demonstration of the Application of the Piezo-electric Properties of a Rochelle Salt Crystal and the Tri-electrode Valve to the Determination of Impact Stresses in Granular Material.* **J. J. Hartley** and **R. H. Rinaldi.** (Phys. Soc., Proc. 38. p. 273, April, 1926.)

1509. *The Optical Study of Percussion Figures.* **C. V. Raman.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 387-390, April, 1926.) —The application of optical interference methods to the study of the small local deformations occurring in impact is indicated as likely to lead to an extension of our knowledge of such deformations. As an illustration of the usefulness of the method, interference photographs showing the surface deformations produced by the percussion of a polished steel ball on a thick glass plate are reproduced. The photographs show the percussion figure to consist of three distinct regions: (*a*) A central area which remains plane and practically undisturbed except for a small permanent lowering of its level; (*b*) a narrow annular region of fracture showing severe injury to the surface; (*c*) a sudden elevation of the surrounding surface which slopes down gradually to the general level of the plate at the outer margin of the area of internal fracture. AUTHOR.

1510. *Variation Principle and Quantum Condition in the New Quantum Mechanics.* **K. Lanczos.** (Zeits. f. Physik, 36. 6. pp. 401-409, 1926.)— In this mathematical paper the Hamiltonian principle of quantum mechanics is treated, so far as a single degree of freedom is concerned, according to the procedure of Born-Jordan [see Abstract 447 (1926)]. It is shown that the variation principle and the quantum condition have not to be regarded as two separate independent principles in a sense that the quantum condition would limit *à posteriori* the freedom of the initial conditions of the dynamical problem. It is rather an *à priori* demand which by variation plays the *rôle* of a subsidiary condition. The energy matrix then appears as a Lagrange multiplier. H. H. Ho.

1511. *Adiabatic Hypothesis for Magnetic Fields.* **P. A. M. Dirac.** (Cambridge Phil. Soc., Proc. 23. pp. 69-72, Feb., 1926.)—The usual proof of the adiabatic invariance of the quantum integrals of a multiply periodic dynamical system assumes that the Hamiltonian equations remain valid for the system with the same Hamiltonian function H, or with a new

H function differing from the old one by terms that vanish with $\dot{a}$, (a) being the varying parameter [Abstract 1809 (1925)]. In most cases of adiabatic change, including all cases in which the change is the result of mechanical change, the Hamiltonian equations are shown to be satisfied. Moreover, whenever there are no forces depending on the velocities, p's and q's can always be found which do not contain a implicitly, leading to the result that the system still satisfies a set of Hamiltonian equations differing from the first. For a system which does involve forces depending on the velocities, there may be no set of p's and q's satisfying the Hamiltonian equations during the adiabatic motion, in which case the quantum integrals will not, in general, be constant. The only important practical case of a system which does involve forces depending on the velocities is that of an atom in an external magnetic field. The Lagrangian of such a system is $L = L_0 - e/c \,.\, \Sigma(A_x\dot{x} + A_y\dot{y} + A_z\dot{z})$, where L_0 is the Lagrangian of the system in the absence of the magnetic field (A_x, A_y, A_z) is the vector potential of the field, and the summation is extended over all the electrons of the system. The momenta are given by equations of the type $p_x = \partial L/\partial\dot{x} = m\dot{x} - e/c \,.\, A_x$, and Hamilton's equations are satisfied, to the first order in A, with the Hamiltonian function $H = H_0 + \Sigma e/c \,.\, (A, v)$ [see Born, Vorlesungen über Atommechanik, pp. 238–239], H_0 being the Hamiltonian in the absence of the field, and v being the velocity of an electron. Here it is found that the Hamiltonian equations would not be satisfied. But actually the change in the magnetic field H must be accompanied by an electric field E satifying $\text{curl } E = -1/c \,.\, \partial H/\partial t$, the general solution of which is $E = -1/c \,.\, \partial A/\partial t - \text{grad } \phi$. Then it is found that $H' = H - e\phi$, so that Hamilton's equations still hold with the new Hamiltonian H'. For a uniform magnetic field H we may take $A = \tfrac{1}{2}[H, r]$, where r is the position vector, this being one of the solutions of the equation $H = \text{curl } A$, and this can no longer be exactly true in that H cannot be uniform in view of the equation $\partial^2H/\partial x^2 + \partial^2H/\partial y^2 + \partial^2H/\partial z^2 = 1/c^2 \,.\, \partial^2H/\partial t^2$. This equation shows that the variations in H are of the order T^{-2}, where T is the time taken to establish the field, so that the error arising from the assumption that $H = \text{curl } A$ is rectified, and the ordinary proof of the adiabatic invariance of the quantum integrals can now be applied. Sommerfeld states [Atombau und Spektrallinien] that if the magnetic field is suddenly introduced the momentary velocity of an electron will not be affected. The equation $\text{curl } E = -1/c \,.\, \partial H/\partial t$ shows, however, that a sudden change in the magnetic field must be accompanied by an impulsive electric field, which will in general cause a finite change in the velocity of the electron. One way of establishing the field is by means of a plane wave advancing in the x direction with the velocity of light and having $E_y = H_z =$ a constant C behind the wave front, the other components of E and H vanishing; also a similar wave advancing in the opposite direction. Then the two waves together establish a uniform magnetic field $H_z = 2C$ and no electric field. Now suppose the field established by such waves coming uniformly and simultaneously from all directions in the xy plane. Then the radial impulse is given by the average value of $(x \cos \alpha + y \sin \alpha)(y \cos \alpha - x \sin \alpha)eH/rc$, which is zero, and the tangential impulse by the average value of $(x \cos \alpha + y \sin \alpha)^2 eH/rc$. The angular velocity imparted to the electron is therefore $r^2eH/2mc$, which is just the Larmor precession. Hence the quantum integrals will remain invariant when the field is suddenly established in this way, since the motion is the same as if when the field is established adiabatically. Any method of establishing a field symmetrical about an axis through the nucleus can be resolved into waves of the type just considered, so that the quantum integrals must also be invariant in this more general case. G. W. DE T.

1512. *Quantisation as a Problem of Characteristic Values.* **E. Schrödinger.** (Ann. d. Physik, 79. 4. pp. 361–376, March 13, 1926.)—The author seeks to replace the customary rules of quantisation by another condition in which the notion of whole numbers does not explicitly occur. In the Hamilton-Jacobi differential equation, $H\left(q, \frac{\partial S}{\partial q}\right) - E = 0$, S is put equal to K log ψ, where K is a constant and ψ is the product of functions, each depending on one only of the coordinates q. It is sought now to choose ψ, not to satisfy the Hamilton-Jacobi equation, but such that the integral of H − E over the whole coordinate space is stationary for an arbitrary variation of ψ, ψ being everywhere real, single-valued, finite, and continuously differentiable up to the second order. The case in which the Hamiltonian function corresponds to Keplerian motion is treated in detail, and it is shown that ψ can be suitably chosen for all positive values of E, but for a discrete group only, of negative values. The latter correspond to the Balmer terms, the former to the energy of hyperbolic orbits. The possible physical significance of ψ as describing characteristic periodic processes in the system is discussed, and a new conception of the Bohr frequency condition is advanced. W. S. S.

1513. *On the Deduction of the Characteristic Equation by the Method of the Virial.* **K. Shiba.** (Phys. Math. Soc. Japan, Proc. 8. pp. 31–40, Feb., 1926.)—Boltzmann deduced, by the method of the virial, the second-order term of van der Waal's characteristic equation, but he calculated the two virials due to molecular volume and cohesion separately. In this paper they are both taken into account simultaneously. The molecular attraction is denoted by $f(r)$, where r is the distance between two molecules, and $f(r)$ is assumed to be appreciable only when r is a little greater than the molecular diameter σ. It is shown that rigorously, on the assumption of the molecules as perfectly elastic rigid spheres, the theory does not admit of the existence of a corresponding state, but as a first approximation the corresponding state may be permissible. H. H. Ho.

1514. *Crystal Structure of Germanium Tetra-iodide.* **F. M. Jaeger, P. Terpstra** and **H. G. K. Westenbrink.** (K. Akad. Amsterdam, Proc. 28. 8–9. pp. 747–766, 1925.)—Crystallographic measurement of germanium tetra-iodide crystals shows that these belong to either the tetrahedral pentagondodecahedral or the diakisdodecahedral doss. X-ray examination indicates a crystal structure in which each germanium atom is surrounded by four iodine atoms, situated at the angles of a regular tetrahedron. It is easily proved from this that of the thirty-two iodine atoms in each cell twenty-four have equivalent positions in the structure and eight somewhat different structural functions. These results are in complete agreement with those of Dickinson's determinations on stannic iodide [Abstract 1526 (1923)]. It is not yet certain if, in the case of germanium tetra-iodide, there is present a structure formed by ions. T. H. P.

1515. *Crystallisation of Glycerine.* **M. O. Samsoen.** (Comptes Rendus, 182. pp. 846–847, March 29, 1926.)—This was discovered accidentally by Chevreul, and has remained mysterious. The conditions of its occurrence are now investigated. The crystals melt at 18°·07 C. A. D.

1516. *X-Ray Examination of the Crystal Lattice of Manganous Fluoride and Manganese Dioxide.* **A. Ferrari.** (Accad. Lincei, Atti, 3. pp. 224–230, Feb. 21, 1926.)—Manganous fluoride crystallises in the tetragonal system, the axial ratio being $c : a = 0{\cdot}675$. Its structure corresponds with the rutile type; the elementary cell, containing two molecules, has the dimensions, $a = 4{\cdot}865$ and $c = 3{\cdot}284$ Å.U. The calculated density 3·97 agrees excellently with the experimental value, 3·98. Manganese dioxide exhibits the same lattice as the fluoride; $a = 4{\cdot}380$ and $c = 2{\cdot}856$ Å.U. The calculated specific gravity, 5·27, is somewhat greater than the experimental value, 5·08, and the axial ratio, $c : a = 0{\cdot}625$, is markedly lower than that found crystallographically, 0·664. The X-ray examination shows that manganese dioxide exists in only one crystalline form: the tetragonal form of polianite. The latter, pyrolusite, and the artificial dioxide undoubtedly show the same lattice. The supposed rhombic form is certainly a pseudomorph. T. H. P.

1517. *Pores in the Crystal Lattice.* **J. Koenigsberger.** (Phys. Zeits. 27. pp. 215–217, April 15, 1926.)—Discusses the question of the existence of sub-microscopic pores in crystals, the presence of which is indicated by accurate determinations of density and which have been used by A. Smekal to explain the method of electrolytic conduction in many crystals [Abstract 455 (1926)]. Describes the changes of form in crystals due to traces of impurities, including cases where the impurity gives colour to the crystal; in many cases there is pleochroism which indicates that the impurity is arranged regularly in the lattice of the crystal. Other facts are considered, and the author concludes that the additional conductivity due to any kind of disturbances (crystal pores) and impurities in mono-crystals must depend in a marked degree on direction in cases where the symmetry of the space lattice indicates a difference between different directions. H. N. A.

1518. *Evidence from Crystal Structures in regard to Atomic Structures.* **M. L. Huggins.** (Phys. Rev. 27. pp. 286–297, March, 1926.)—The distribution of valence electrons in the diamond and similar crystals.—Because of the cubical symmetry, the equivalent scattering power of all the atoms, and the absence of pyro- and piezo-electric effect, the atoms in the diamond cannot be held together as a result of the transfer of electrons from atom to atom. Symmetry requirements also eliminate any cubical arrangement of electrons or orbits around each atom. The diamagnetism of H_2 and of most organic compounds eliminates rotations of two electrons or orbits in the same direction about each atomic centre-line as a means of holding the atoms together. Similar structures and numbers of valence electrons, together with inter-atomic distance comparisons, indicate that the atoms in BeO, ZnO, ZnS, CdS, AgI, etc., are held together in a manner similar to that in the diamond. If so, there cannot be four electrons rotating around each atomic kernel in the diamond, for Zn^{--}, Ag^{---}, O^{++}, etc., are chemically impossible. It is not possible for two electrons to be rotating about each two adjacent atomic kernels in crystals of NaCl, MgO, CdO, AgBr, etc., and since chemically and physically these are not very different from BeO, CdS, AgI, etc., the bonds in the last-named crystals and so in the diamond are probably not of this type. The conclusion is therefore reached that in the diamond and crystals of similar structure, the electrons are in pairs at tetrahedron corners around each atom, each pair being held jointly by two atoms. This is as predicted from the Lewis theory of valence. A study of the other known crystal structures leads to the conclusion that in general the valence shells of electro-negative atoms are tetrahedra of electron pairs rather than cubes of single electrons. AUTHOR.

1519. *Mathematical and Statistical Investigation on Sub-electrons. II.* **H. Daecke.** (Zeits. f. Physik, 36. 2. pp. 143–146, 1926.)—An attempt is made to show that in the measurements of König and of Radel there exists a relation between the charge on the particle and its radius. The correlation coefficients, charge-radius, are calculated for five series of observations in each of which the mean charge approximated to the normal value, 4·77 . 10^{-10} e.s.u. In four cases the coefficient lies between ⅓ and ½, which the author accepts as indicating a marked interdependence of charge and radius. The form of the relation and its cause are not discussed. [See Abstract 788 (1925).] W. S. S.

1520. *Relation between the Completion of the Electron Groups in the Atom and the Chemical Valency Numbers.* **H. G. Grimm and A. Sommerfeld.** (Zeits. f. Physik, 36. 1. pp. 36–59, 1926.)—Spectroscopically the completion of a sub-group of the periodic system is characterised by the quantum number $j = 0$ of the fundamental term, and the value of j for the immediately preceding or succeeding elements may be determined from the systematics of the periodic system. The spectroscopic facts confirming these laws are completed in the present paper. The different spectroscopic and chemical behaviours of silver on the one hand and of copper and gold on the other are explained in terms of the spectroscopic character of the fundamental term of the preceding elements. A suggestion is made for the elaboration of the classification of terms suggested by Russell and Saunders [Abstract 1382 (1925)]. Chemically there is a tendency towards not only the 8- and 18-shells, but also the 2- and 4-shells (completion of the n_{11} and n_{12} groups). The 2-shell appears with the compounds (partly of polar structure) of the elements of the so-called sub-series. The occurrence only of the diamond and wurtzite type among the neighbours of carbon, silicon, germanium, tin, and lead is indicated by the fact that there is a tendency to the electronic configuration of the diamond in compounds like AlN, BeO, ZnS, etc. Energy considerations in a number of examples show quantitatively that the establishment of the polar or the non-polar type of combination depends on the energy content of the compounds. T. H. P.

1521. *On the Dynamics of the Helium Atom.* **V. Trkal.** (Zeits. f. Physik, 36. 3. pp. 194–214, 1926. Paper read before the Böhmische Akad.)—The investigation described in this mathematical paper treats the problem of the helium atom analogously with that of the hydrogen atom for a singular case (Q_1 = const.). (For He: sum of the squares of the distances of the electrons from the nucleus is constant; for H: the electronic orbits are circular.) Born and Heisenberg's work [see Abstract 2364 (1923)] is discussed. To accomplish this end the Hamiltonian function for the three-body problem of the helium type is made similar to that of hydrogen, and by the disappearance of the time change of the Hamiltonian function (on account of the constant energy), the hypothesis of the singular case $Q_1 =$ const. is then rendered possible. It is shown that for this particular case the energy of the helium atom $W = -2\pi^2 me^4 Z^2/J_2^2$, where Z is a function of the quantum numbers. From the Jacobian proposition dealing with the average value of the potential and kinetic energy for the Coulomb field there is next derived the general form of the energy constant as a function of the effective variables. As a counterpart to the equation for the frequencies, $V_k = \partial w(J)/\partial J_k$, the expression for the determination of the effective variables is found to be $J_k = \partial \overline{L(v)}/\partial v_k$. H. H. Ho.

1522. *On the Stability of the Atomic Nucleus.* **L. Strum.** (Zeits, phys. Chem. 119. pp. 368–376, March 25, 1926.)—The author discusses the structure of the atomic nucleus from the standpoint of an empirically found connection between atomic weight and order of an element, and relations are derived between the numbers of separate nuclear components, viz. α-particles, helium atoms, protons and electrons. From considerations on the stability of the atomic nucleus a comparison has been drawn between the numbers of protons and electrons in the atomic nuclei of different elements. H. H. Ho.

1523. *Theory of the Bucherer Experiment.* **N. A. Smirnow.** (Ann. d. Physik, 79. 3. pp. 227–236, March 8, 1926.)—The effects of compensated and uncompensated rays upon the form of the trace obtained in the Bucherer experiment are discussed mathematically. [See also Abstracts 1562 and 1563 (1925).] J. S. G. T.

1524. *Tests of Relativity Theory.* **A. S. Eve.** (Nature, 117. pp. 520–522, April 10, 1926. Paper read before the Phys. Soc. of McGill Univ., Montreal, Jan., 1926.)—The experimental verification of Einstein's three crucial phenomena and the work of Miller on ether-drift and of Gale on the first-order effect suggested by Michelson are briefly referred to. J. S. G. T.

1525. *An Absolute Space following from the Principle of the Conservation of Energy.* **U. Doi.** (Phys. Math. Soc. Japan, Proc. 8. pp. 21–30, Feb., 1926.)—It is shown that if the principle of the conservation of energy be valid for energy exchange between a material system and radiation, this can be so only when a certain unique reference system—"an absolute space"—is considered. J. S. G. T.

1526. *On a Set of Quartic Surfaces in Space of Four Dimensions, and a Certain Involutory Transformation.* **H. G. Telling.** (Roy. Soc., Proc. 110. pp. 700–708, April 1, 1926.)—The mutual relations of fifteen quartic surfaces are considered together with their intersections. It is shown that two of these fifteen surfaces associated with two skew lines of the fundamental configuration have one point in common besides the given common point, together with three skew lines and their common transversal, these being the lines of the original fifteen not meeting the two lines with which the surfaces are associated. The treatment is wholly mathematical. R. S. R.

1527. *Einsteinian Gravitation Equation.* **S. C. Kar.** (Phys. Zeits. 27. pp. 208–210, April 1, 1926.)—Works out a solution of the Einsteinian gravitation equation for the field of an infinite material plane uniformly charged with electricity. A. D.

1528. *The Problem of Two Bodies when the Mass is a Linear Function of the Time.* **G. Vranceanu.** (Accad. Lincei, Atti, 3. pp. 192–196, Feb. 21, 1926.)—A purely mathematical discussion. The assumption made is that $f(M + m) = a + \lambda t$, where M, m are the masses, f the coefficient of attraction, t the time and a and λ constants. The method outlined can also be applied when $f(M + m)$ is any polynominal in t. A. Wh.

1529. *The Variability of Mass in Relation to the Problem of Two Bodies.* **G. v. Gleich.** (Zeits. f. Physik, 36. 2. pp. 150–160, and 36. 6. p. 480, 1926.)—The formula based upon that proposed by Whittaker for variability of mass is shown to be an approximation, which takes slightly different forms in the case of a gravitational and a Coulomb field respectively. The general theory of relativity, more especially the Einstein expression for the line-element, is shown to be irreconcilable with the fine structure of spectral lines. [See Abstract 467 (1926).] Several arithmetical errors are corrected in the second note. J. S. G. T.

METEOROLOGY AND GEO-PHYSICS.

1530. *Experiments on the Shielding of Rain Gauges.* **C. D. Stewart.** (Roy. Meteorolog. Soc., J. 52. pp. 55–70; Disc., 70–72, Jan., 1926.)—Investigations have been made at Valencia Observatory to determine the shielding effect produced by buildings, trees, hedges, etc., in measuring rainfall. The results indicate that any object at a distance from the rain gauge greater than twice its height will not cause any loss by direct screening, while a downward slope from object to gauge is an advantage. As regards any shielding which may be produced the direction of the prevailing wind is more important than its speed. The Nipher rain gauge shield makes for uniformity in all wind directions, but its effectiveness decreases with rising wind speeds. There is an improvement of 5 % in measured rainfall for high wind speeds and of 4 % for low wind speeds (*i.e.*, < 9m./sec.). Experiments made by exposing rain gauges in pits prove that greater protection results than with the Nipher shield. For a pit with sloping or vertical sides the catch is increased by 10 %, showing that it is better in rainfall measurements to eliminate eddies than to counteract them. R. S. R.

1531. *The Dynamics of Geostrophic Winds.* **H. Jeffreys.** (Roy. Meteorolog. Soc., J. 52. pp. 85–101; Disc., 102–104, Jan., 1926.)—The analogy is first drawn between tides and large-scale motion of the atmosphere, and it is inferred that for every problem of the atmosphere produced by changes of temperature or composition over large regions of the earth's surface there is a corresponding tidal problem, and a solution of the latter leads to a solution for the former. The nature of the general circulation in the absence of friction is examined and the results applied to monsoons and the general circulation. Neglect of friction leads to a general easterly circulation which is at variance with facts. Including friction, the necessity for permanent low-pressure regions round each pole is indicated, and if there is any polar circulation it can be maintained only if there is interchange of air with regions of lower latitudes. This involves a system of cyclones whose heights are comparable with those of the homogeneous atmosphere and the troposphere. The structure of the cyclones is similar to the Bjerknes model, but friction plays an important part in producing them in the first place. Thus dynamical theory leads to a westerly circulation around the poles and easterly circulations in middle latitudes or near the equator, and a system of cyclones similar to those observed. R. S. R.

1532. *Measurements of the Amount of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions.* **G. M. B. Dobson** and **D. N. Harrison.** (Roy. Soc., Proc. 110. pp. 660–693, April 1, 1926.)—Measurements have been made on every possible day during 1925 of the amount of ozone, employing spectrograms of sunlight and determining the intensity of the ultra-violet absorption band due to ozone. On a number of days it was possible to obtain a series of twelve pictures in one morning or afternoon, thus working with different altitudes of the sun. The apparatus was designed to be convenient for outdoor use, to have a dispersion not less than 15 Å. per mm. and to eliminate all undesired light of longer wave-lengths. The last was effected by passing the light through a tube of transparent silica with fused ends which contained Br and Cl in amounts chosen by trial. The various possible sources of error are discussed. The mean values of ozone expressed as a thickness in cms. of an equivalent layer of ozone at N.T.P. are tabulated for every day tested in 1925 together with barometric pressure and sunspot numbers. It was found that a yearly period occurred with a maximum in spring and a minimum in late autumn, but the effect was complicated by superimposed pressure changes. There were indications of a 27-day period during May–August. An inverse relation with surface-pressure was found the changes in amount of ozone tending to reach a maximum 1–2 days after the change of pressure. Well-marked secondary depressions, which are probably shallow, affect the amount of ozone very little. There is a high correlation between the amount of ozone and the pressure in the upper air as found by *ballon sondes.* Usually high sunspot numbers give low ozone values. The formation of the ozone and the height at which it occurs are discussed. During 1926 extended measurements are to be taken at six stations in N.W. Europe and also at Montezuma, Chili, to establish the results. [See also Abstracts 242 and 475 (1926).] R. S. R.

1533. *Atmospheric Ozone and Terrestial Magnetism.* **C. Chree.** (Roy. Soc., Proc. 110. pp. 693–699, April 1, 1926.)—The values obtained by Dobson and Harrison [see preceding Abstract] for the amount of ozone in the atmosphere have been compared with the Greenwich value of the magnetic character of these respective days. The results indicate that higher ozone values occur with increased magnetic disturbance and that for both quantities there is a tendency to runs of high and low values. R. S. R.

1534. *Physical Theory of Meteors.* **C. M. Sparrow.** (Astrophys. J. 63. pp. 90–110, March, 1926.)—Heating of a meteor by molecular impacts.—When the free path of air molecules is not small compared to the dimensions of the meteor, the ideas of fluid motion are inapplicable, and the "friction" of the air is seen as a succession of individual molecular impacts. Assuming this input of energy to be balanced by radiation losses, the temperature may be calculated when the speed and the composition of the air are known. Height of appearance.—When the evaporation of the solid body becomes copious, the accession of energy is much increased because of the greater effective size of the gas-mantle. The meteor then becomes visible. The theory is shown to give results in good agreement with observed heights of appearance and with the data concerning the upper air which are furnished by the meteorologists. Criticism of theory of Lindemann and Dobson.—The theory of these writers rests on the assumption of adiabatic compression of the air by the moving meteor. It leads to the assumption of pressures and temperatures in the upper air far higher than have been generally accepted. Their use of thermodynamic concepts is here seen to be unjustifiable, and hence their conclusions unwarranted. Origin of Meteors.—That a large proportion of meteors come from outside the solar system is contrary to this theory, the hyperbolic velocities giving a height of appearance much greater than that of the Leonids, and such are relatively rare. AUTHOR.

1535. *Measurement of Resistivity of Large Masses of Undisturbed Earth.* **O. H. Gish** and **W. J. Rooney.** (Terrest. Magn. 30. pp. 161–188, Dec., 1925.)—The method and equipment for measuring the resistivity of large masses of undisturbed earth, primarily in connection with earth-current potential measurements at the Carnegie Institution of Washington, magnetic observatories at Watheroo (Western Australia), and at Huancayo (Peru), are described. Measurements, made at four sites in the vicinity of Washington, D.C., during the development of the method, are reported. Method and procedure are described in Part I. Four contacts to earth are provided at equal intervals along a straight line at the surface. A measured current is sent through the earth between the extreme points and the resulting difference of potential between the intermediate points is observed. These data, together with the length of interval between electrodes or contact points, yield the average resistivity of a body of earth whose linear dimensions are of the same order as that of the electrode interval. Part II summarises the results of a series of measurements with electrode intervals ranging from 5 ft. (1·5 metres, to 1800 ft. (540 metres). These give some knowledge of the variation of resistivity with depth and determine approximately the depths of ground-water and of changes in the geological substructure. AUTHORS.

1536. *Influence of Induction and Capacity in Measurements of Geophysical Lines of Potential for Alternating Currents.* **W. Heine.** (Phys. Zeits. 27. pp. 219–224, April 15, 1926.)—An alternating current method can be used directly to determine the equipotential lines and thus the geophysical construction of the earth's crust where the conditions are uniform. Where differences exist due to better or poorer conductivity self-induction and capacity alter the uniform run of these lines. These produce a phase difference between current and potential difference.

Calculations are made to determine the elliptical displacement of the potential vector, the dependence of the axes of this ellipse on the phase angle, and the rotation from the original current direction, the effects of (1) local differences of ohmic resistance and (2) natural condensers in the earth's surface being considered separately. In this way the presence of other kinds of rock and the general slope and position of these layers can be located. R. S. R.

1537. *Insular Gravity and Oceanic Isostasy.* **J. Larmor.** (Cambridge Phil. Soc., Proc. 23. pp. 130–135, April, 1926.)—The paper commences with a discussion of the Stokes explanation of the anomaly shown by island stations where gravity is found to be abnormally in excess of theoretical requirements. The Stokes explanation is shown, however, to fail because there is a predominant offset which may destroy and even reverse it. Following this comes first a discussion of the data of the Indian geodetic survey of 1855–9, followed by one on Bowie's recent report on "Isostasy in the Southern Pacific" [Washington Acad. Sci., Proc. p. 445, Dec. 4, 1925]. In the latter, local isostasy was found to account for about three-fourths of the observed local excesses in *g*, which are there of the order of over 0·1 in 981. Generally, the conclusion is that the depression of sea-level at island stations is not adequate by itself to counteract the direct diminution in gravity due to the low density of the attracting water, much less to produce the observed excess. But if the oceanic defect of density is deeply compensated underneath, down to a uniform standard depth of ocean, any local anomaly of gravity should be due simply to the excess mass over that of water up to an ideal level surface of the local land standing in this ocean. H. H. Ho.

1538. *The Stability of a Strut under Thrust when Buckling is resisted by a Force proportional to the Displacement.* **S. Goldstein.** (Cambridge Phil. Soc., Proc. 23. pp. 120–129, April, 1926.)—In this mathematical paper it is shown that for both a clamped and a pinned strut there is stability for any length when the thrust is less than a certain critical value. A relation is then derived between the length and the first value of the thrust above the critical value when buckling occurs. A motion of the wave-length and number of modes after buckling is next obtained. The results are applied to the theory of the formation of mountains by horizontal compression, and it is shown that the crust of the earth would be able to transmit, without buckling, stresses right up to the breaking stress across regions of continental extent, unless the depth down to the level of no strain were less than 16 metres. An attempt is made to employ the results, also to consider the stability of solid surface films under compression, and it is seen that other factors, making for stability, must enter besides rigidity and gravity. This is supplied by surface-tension, and it then appears that collapse due to a weakness in the film must precede buckling. Finally, a rough calculation is given of the frequency of vibration of an atom in a solid film. H. H. Ho.

ASTRO-PHYSICS.

1539. *The Results of Astronomical Observations and the Ballistic Theory of Light.* **W. E. Bernheimer.** (Zeits. f. Physik, 36. 4. pp. 302–310, 1926.)—It is shown that observations on the sun do not confirm the validity of the use of the ballistic principle for the movement of a luminous atom in the gravitational field of stars, and the results are in contradiction. The application of the values of the quantity *Kb* to astronomical data, such as photometric and parallax measurements, is strongly criticised. The argument is applied to O Ceti, and it is shown that the ballistic theory will not hold. The paper is a further contribution to the la Rosa controversy [Abstract 276 (1925)]. S. G. B.

1540. *Height of Solar Chromosphere.* **G. Abetti.** (Accad. Lincei, Atti, 3. pp. 140–144, Feb. 7, 1926.)—Discusses the observations of Arcetri, Catania and Madrid during 1921–1925. The height, greater towards the Poles, rose from 1921 into 1922, and has since been falling. A. D.

1541. *Selective Radiation Pressure and the Accelerated Motion of Ca^+ Vapour in Eruptive Prominences.* **R. K. Sur.** (Astrophys. J. 63. pp. 111–121, March, 1926.)—An attempt has been made to explain the motion of eruptive prominences. The great heights reached by certain elements in the solar chromosphere cannot be explained by the theory of a pressure gradient due to solar gravity or by any electrical theory. On the assumption that the ionised calcium vapour in the high-level chromosphere is supported against gravity by radiation pressure, Milne has given [Abstract 1726 (1924)] by applying Einstein's theory of radiation, a calculation of the average life of an excited Ca^+ atom in the 1*s* state which agrees well with the experimental result of others. These ideas have been extended to show that an increase of temperature of any portion of the photosphere above the surrounding parts will destroy the equilibrium of the gaseous mass above it. The excess of the radiation pressure over the solar gravity produces an acceleration, the magnitude of which depends upon the temperature, the shape, and the size of the bright patch developed and the distance of the gaseous mass under consideration. The motive power for the motion of eruptive prominences is thus furnished by selective radiation pressure. According to Einstein's theory of radiation the moving mass of gas will experience a force of resistance proportional to velocity which will reduce the motion to one of constant limiting velocity. The impulsive changes of velocity are due to sudden changes of temperature at the base. AUTHOR.

1542. *Photograph of Shadow Bands.* **A. E. Douglass.** (Astrophys. J. 63. pp. 188–190, April, 1926.)—The author's earlier experiments in photographing heat-currents and atmospheric waves indicated that the apparatus could be used also for photographing the shadow bands at a total solar eclipse. This was accomplished on January 24, 1925, at Middletown, Connecticut, with the author's apparatus, under the auspices of the expedition from the Harvard Astronomical Laboratory. AUTHOR.

1543. *An Attempt to Detect Water-Vapour and Oxygen Lines in the Spectrum of Mars with the Registering Microphotometer.* **W. S. Adams** and **C. E. St. John.** (Mt. Wilson Observat. Contrib. No. 307. Astrophys. J. 63. pp. 133–137, March, 1926.)—If water-vapour and oxygen are present in the atmosphere of Mars, the motion of the planet with reference to the earth should produce a relative displacement of the lines due to these gases in the two spectra. Spectrograms of Mars and the sky were made with a six-prism spectrograph, the scale being 1 mm. = 7·3 Å. at D, and graphs were drawn by a registering microphotometer on a scale of 1 mm. = 0·12 Å. The lines of water-vapour and oxygen in the graphs of the two spectra were superposed, and the relative displacements of the solar lines were then read directly from the curves. The water-vapour lines in the spectrum of Mars were displaced 0·03 ± 0·01 Å., and the oxygen lines 0·09 ± 0·03 Å. to the red, with respect to their positions in the sky spectrum. On taking account of the Doppler displacement, the length of path in the two atmospheres and the amounts of water-vapour and oxygen above Mt. Wilson, the quantity of water-vapour in the atmosphere of Mars, area for area, was found to be approximately 3 % of that over Pasadena, and the quantity of oxygen two-thirds of that above Mt. Everest. AUTHORS.

1544. *Planetary Temperatures derived from Water-cell Transmissions.* **D. H. Menzel, W. W. Coblentz** and **C. O. Lampland.** (Astrophys. J. 63. pp. 177–187, April, 1926.)—In this paper the measurements of the planetary radiation transmitted through a water cell as observed by Coblentz and Lampland at the Lowell Observatory during the summer of 1924 are reduced by Menzel by the method published by him in 1923 [see Abstract 449 (1924)]. The results obtained seem to prove quite conclusively that the bright areas are at a lower temperature than the dark areas, and that the equatorial (black-body) surface temperature of Mars at perihelion rises above 0° C. The true temperature, corrected for emissivity, would be about 10° higher. The temperature of the south polar cap was − 100° C. on August 14, gradually increasing to about − 15° C., on October 22, indicating that the cap is probably composed of ice and snow. The low temperature of the east limb, which was down to − 85° C., is definite proof of an enormous diurnal fluctuation. Various methods of combining the observations give concordant results. The temperature of the moon reached 120° C. under perpendicular insolation. The distribution of energy in its heat spectrum is not consistent with a radiating surface of quartz. The temperatures of Jupiter, Saturn and Uranus are low, the values calculated from the water-cell transmission being − 150° C., − 150° C., and − 170° C. respectively. There is little evidence of internal heat. AUTHORS.

1545. *Three New Variable Stars.* **K. Bohlin.** (Astron. Iakttagelser och Undersökningar, Stockholm, 11. 1. [31 pp.], 1925.)—The author gives a detailed account of his observations, visual and photographic, between the years 1921 and 1924, of three stars, with a chart and a diagram of the light-curve for each. The first, provisionally called N Aquilæ, is of Antalgol type, with a period of 10·4 days and a prolonged steady maximum of nearly three days; it should probably be classed among Cepheids of unusual type. The second, AA Aquilæ, is a typical Cepheid, with a period of half a day and variation between 9½ and 11 magnitude. The third, provisionally named N Geminorum, has a period of three years, with a well-marked secondary maximum, but further observation is desirable, as the amplitude is not more than one magnitude and the star is very red. M. A. E.

LIGHT.

1546. *True Absorption of Light.* **T. Bialobjeski.** (Ann. de Physique, 5. pp. 215–264, March–April, 1926.)—A very long paper dealing with that portion of the energy of radiation which is transformed into heat. The problem is treated from both the classical and the quantum theory point of view. A short bibliography of thirty references is given. The original paper should be consulted. W. H. GE.

1547. *Light-absorption by Normal and Metastable Tungsten and Molybdenum.* **H. B. Dorgelo.** (Zeits. f. Physik, 36. 6. pp. 467–471, 1926.)—Molybdenum gives noticeable absorption by metastable quintet S and D terms and tungsten gives different lines corresponding to combinations with the quintet D terms and the septet S term. A. D.

1548. *Atmospheric Absorption and Transmission in Searchlight Practice.* **R. M. Langer.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 359–373, April, 1926.)—The visibility of an object in a searchlight beam is considered as a function of (1) the spectral composition of the light; (2) the intensity of the beam at the source; (3) the shape of the beam; (4) luminosity of the beam due to scattered light; (5) meteorological conditions, such as air currents, turbulence, dust, fog, rain, etc.; (6) physical conditions and their changes with time and altitude; (7) altitude of the object; and (8) distance to the object. Such factors as the character of the light are under control, others may be determined (meteorological), but for several further physiological research is necessary. R. S. R.

1549. *Diffuse Light Reflection.* **G. I. Pokrowski.** (Zeits. f. Physik, 36. 6. pp. 472–476, 1926.)—Goes on to consider the case where the reflection may be at any angle to the normal and to the direction of incidence. [See Abstract 973 (1926).] A. D.

1550. *Reflection of Radiation from a Finite Number of Equally Spaced Parallel Planes.* **T. H. Gronwall.** (Phys. Rev. 27. pp. 277–285, March, 1926.)—Equations are derived for the fractions of the incident energy which are absorbed, reflected and transmitted by $n + 1$ equally spaced parallel planes, taking account of all possible internal reflections, in terms of the corresponding fractions for a single plane a, r and t respectively. When a and r are very small, as in the case of X-rays incident on a crystal surface, they may be computed from measurements of the reflected fraction R_N for N large, and of the transmitted fraction T_n, for n small. AUTHOR.

1551. *Significance and Detection of Low Errors of Refraction.* **O. Aves.** (Optical Soc., Trans. 27. 3. pp. 191–198; Disc., 198–202, 1925–1926.)—Examination of a great number of records of tests on the eye for the purpose of prescribing spectacles reveals the large proportion of low errors of refraction. The author suggests certain modifications of the usual technique that, in his opinion, should be incorporated when testing such cases. AUTHOR.

1552. *Exner Polarimeter.* **O. Tomaschek.** (Akad. Wiss. Wien, Ber. 134. 2a. No. 7–8. pp. 317–323, 1925.)—Gives a description and theory of the Exner polarimeter and its application to the measurement of the degree of polarisation of the light reflected from crystal surfaces. W. H. Ge.

1553. *The Nature of the Polishing Operation.* **F. W. Preston.** (Optical Soc., Trans. 27. 3. pp. 181–190; Disc., 190, 1925–1926.)—The status of the "flowed" layer on glass, quartz, and similar materials which have been ground or polished is unsatisfactory. The present paper calls attention to a number of phenomena that seem to bear on this subject and might serve as starting-points for interesting researches. It is believed that interesting relevant observations have been made by a number of people, who could contribute to a symposium, and by so doing make clear how much agreement or disagreement there is on the subject, and so prepare the field for future investigators. Author.

1554. *Vertex Power and its Measurement.* **W. H. A. Fincham.** (Optical Soc., Trans. 27. 3. pp. 203–212; Disc., 212–214, 1925–1926.)—The object of the paper is to explain in a simple manner some of the problems involved in the designation and measurement of the power of ophthalmic lenses. The various ways in which the power may be expressed are discussed and the existing methods of measuring power are described, with special reference to the measurement of vertex power. An instrument for this purpose is described and the results of measurements on a number of lenses are given. Author.

1555. *A General Utility Reading-Lens for Burettes and Thermometers.* **E. Q. Adams.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 375–377, April, 1926.)—A reading-lens for burettes and thermometers is described in which errors due to parallax are eliminated by an ocular slit at a distance in front of the lens equal to its focal distance. Spring clips above and below the lens tube give a high degree of rigidity combined with applicability to a wide range of burette or thermometer diameter. For reading the lowest point of the meniscus in burettes filled with a colourless liquid, a spring of sheet brass holds against the back of the burette a suitable ruled background. Two types of background are described, giving either maximum ease and precision of reading, or else speed by obviating the necessity for an accurate placing of the reading lens. Author.

1556. *Differential Microphotometer.* **A. Danjon.** (Rev. d'Optique, 5. pp. 55–62, Feb., 1926.)—The instrument is designed to measure differences of density between two neighbouring regions of a negative, or a photometric wedge. It is a fringe photometer without a diffusing screen, the image of the negative being formed near the pupil on an eyepiece and the disappearance of the fringes depending on the inclination of a pile of plates calibrated by means of a nicol. W. H. Ge.

1557. *A Special Camera for Photographing Cylindrical Surfaces.* **R. Davis.** (Bureau of Standards, Sci. Papers, No. 517. pp. 515–526, 1926.)—This paper describes a camera designed to photograph the entire outside surface of short lengths of pipe which have been subjected to soil corrosion tests. The pipe is rotated by means of a belt which is driven by a pulley of the camera which also shifts the film. The film moves at a speed equal to the image velocity of the pipe. An automatic switch stops the camera after the complete surface of the pipe has been photographed. In this way a complete and clear picture of the pipe surface is obtained in a single photograph. The general design is, of course, applicable to photographing other cylindrical objects. AUTHOR.

1558. *Grating Spectrograph in Vacuo for Study of the Extreme Ultraviolet.* **L. and E. Bloch.** (Rev. d'Optique, 5. pp. 63–71, Feb., 1926.)—To eliminate the absorption which occurs near λ1300 Å. for fluorspar, lower wave-lengths were obtained by using a concave grating of 1 metre radius and with 571 lines per mm. The apparatus consisted essentially of a cylindrical tube containing stages to support the grating and the photographic plates and any required movement of these stages can be obtained from outside, after the doors to the tube are closed, by means of screws passing through airtight joints. Several pictures can be obtained successively in different parts of the same plate. Arc and spark illumination for C and Al electrodes were used, the light passing to the grating through a window covered with an adjustable diaphragm. When arranged as required the interior of the tube is evacuated by a Holweck molecular pump to a pressure of 0·001 mm. and the residual gases in the electrodes are removed. Exposures of 6–30 minutes are required for Schumann plates sensitised by oil. In this way it has been possible to extend measurements satisfactorily down to λ500 Å. Photographs and diagrams of the apparatus and of the carbon spectrum are reproduced. R. S. R.

1559. *Magneto-optical Phenomena in Rapidly Varying Fields.* **O. M. Corbino.** (Accad. Lincei, Atti, 3. pp. 173–177, Feb. 21, 1926.)—Under the classical theory the Zeeman-effect must present absolute instantaneity with variations in the field whatever may be the law of these and whatever their rapidity. Rotatory magnetic polarisation quantitatively follows, in CS_2, the oscillations of a high-frequency field down to the shortest waves (300 metres) experimentally usable. The passage of light through crossed prisms is qualitatively observable with damped variations of wave-lengths down to 60 cms. A. D.

1560. *A Polarisation Phenomenon in the Flow of Electricity through Electrically Doubly Refracting Nitrobenzol.* **O. Lohaus.** (Phys. Zeits. 27. pp. 217–218, April 15, 1926.)—Quincke found that the electrical double refraction of carbon bisulphide was greater when the voltage was first applied than after an interval, and Leiser explained this by supposing that the fall of potential between the plates of the Kerr condenser, which was originally linear, was altered owing to a small flow of current and a local concentration of ions so that it was larger near the electrodes and smaller in the space between them, where the double refraction was observed. The author has constructed a very small Kerr condenser, using small electrodes of carbon, so as to avoid reflections from metal surfaces; and examining it with a microscope, when the space between the electrodes was filled with nitrobenzol and the electric field made an angle of 45° with the planes of polarisation of the crossed nicols, found that near one of the electrodes the brightening of the dark field was much greater than in the space between the electrodes. The distance from the electrode up to which this extra brightness could be observed was some 0·01 mm. H. N. A.

1561. *Depolarisation of Diffused Light.* **J. Cabannes and J. Granier.** (Comptes Rendus, 182. pp. 885–888, April 7, 1926.)—The depolarisation of light diffused by some thirteen organic substances has been measured by a method giving an accuracy of 1–5 %, and the results are briefly discussed and compared with those of other workers. W. H. Gr.

1562. *Experiment on Capacity for Coherence of Light.* **W. Gerlach and A. Landé.** (Zeits. f. Physik, 36. 3. pp. 169–173, 1926.)—Light quanta laws have hitherto met serious difficulty in interpreting interference phenomena. In certain circumstances it is suggested that spatially different elementary bundles may interfere. Generally the different elementary bundles are detached, and from the classical wave theory only under specially foreseen circumstances will coherence and interference be expected. Details are given of an experiment when Newton's rings are produced on a screen provided with two slits. The light transmitted through these slits produces a more extensive interference system, showing that coherence exists within each elementary bundle. These two slits were used in positions of maximum and minimum intensity in the interference line system and the changes in the second interference system noted. Thus while the Planck radiation laws allow for interference of light quanta within an elementary bundle, the experiment described proves this for light quanta in a widely separated bundle. R. S. R.

1563. *Scattering of Light due to Molecular Roughness at the Surface of Separation of Two Transparent Media.* **R. Gans.** (Ann. d. Physik, 79, 3. pp. 204–226, March 8, 1926.)—The present paper, which is mathematical, forms an extension of earlier work [Abstract 2028 (1924)] to the more general case of reflection at the surface of separation of two transparent media. General equations are obtained for the diffuse radiation and the state of polarisation of the scattered light. Reference is made to experimental results obtained by Mandelstam for CH_3OH and CS_2 in the neighbourhood of the critical temperature (*i.e.*, where the liquids are just miscible) which confirm the results obtained mathematically by the author. R. S. R.

1564. *Photographic Effect of Slow Electrons.* **G. F. Brett.** (Leeds Philosoph. and Lit. Soc., Proc. 1. pp. 1–5, Oct., 1925.)—Owing to the difficulty of recording electrons of speed less than 1000 volts by ordinary photographic films, the method of sensitising described by Duclaux and Jeantet was tried, tap grease being substituted for machine oil owing to its lower vapour-pressure. A solution of the grease in ether is applied to the film and washed off with ether after exposure, Kodak duplitised X-ray film being used to prevent curling. A very considerable increase of blackening is recorded for electrons corresponding to only 65 volts. It is proposed to use the method for examining the change of speed of electrons by passage through atoms of an element. F. S.

1565. *Luminescence of Solids.* **J. Ewles.** (Leeds Philosoph. and Lit. Soc., Proc. 1. pp. 6–10, Oct., 1925.)—The view that luminescence is due to impurity present in solid solution is confirmed by X-ray analysis, the lattice dimensions varying with the impurity. This is held to support the view of the writer [see Abstract 1922 (1923)] that kathode luminescence is emitted by the impurity as a sort of nucleus with a large number of other molecules clustered round. Attempts have been made to find the minimum speed of kathode-rays for excitation, and ZnO has been excited by 60-volt electrons. The rate of decay of phosphorescence is considered and also the fact that there is an optimum concentration of impurity. It is hoped to show by X-ray analysis that solid solution is necessary and that structural changes take place during luminescence. F. S.

1566. *The Energy Output of Fluorescence Radiation of Fluorescein Solution with "Non-Stokesian" Excitation.* **S. Valentiner** and **M. Rössiger.** (Zeits. f. Physik, 36. 2. pp. 81–91, 1926.)—A continuation and confirmation of earlier experiments [Abstract 2494 (1924)]. By illuminating fluorescein solution with narrow bands of the spectrum of a tungsten arc and by simultaneous measurements of the energy absorbed and the distribution of energy in the excited fluorescent spectrum it is found that the longer the wave-length of the exciting light the weaker is the fluorescence. To get more strictly monochromatic light a mercury-vapour lamp has been used in the latest experiments. The results of these confirm the earlier ones; there is a large decrease in the energy emission when part of the excited spectrum is shorter in wave-length than the exciting light. On the basis of the results an attempt is made to explain the breaking down of Stokes' law. J. E.

1567. *On the Extinction of the Resonance Fluorescence of Sodium-Vapour.* **R. Mannkopff.** (Zeits. f. Physik, 36. 4. pp. 315–324, 1926.)—The extinction of resonance fluorescence of sodium-vapour by the addition of a mixture of neon and helium, of hydrogen and of oxygen was investigated. The collision radius of the excited Na atom is calculated from the intensity changes and comes out as 1·7 times as great as the value calculated by Thomas [Abstract 2431 (1924)] for the $2p_1$ and $2p_2$ orbit. An application of a formula of Stern and Volmer [Abstract 897 (1919)] to the intensity effects of hydrogen collisions observed by Wood gives an approximation of the collision radius of the same order. J. E.

1568. *Contributions to the Knowledge of Samarium Phosphors.* **M. Travniček.** (Ann. d. Physik, 79. 3. pp. 237–260, March 8, 1926.)—The results of several years' work on Samarium phosphors are given and discussed in relation to the theory of luminescence. Detailed descriptions are given of the mode of preparation of sulphide phosphors, oxide phosphors, mixed phosphors and sulphate phosphors of the alkaline earths activated with Samarium. The spectra are described with diagrams and wave-lengths. As in the case of all other phosphors activated with rare earths, the spectra of these show groups of bands, each group consisting of narrow bands. Though the members of each group appear to be related to each other, they show individuality in that their relative intensity or even existence may be affected differently by different conditions (temperature, etc.). Two suggested explanations are offered.

A comparison of the positions of the bands in the different alkaline earth salts shows that for any given band there is a progressive shift—to the violet in the case of the sulphides and sulphates, and to the red for the oxides. This shift appears to be a linear function of the molecular weight of the "base." The addition of inactive material (*e.g.*, MgO) appears not to alter the position of the bands, from which it is concluded that the ground stuff (*e.g.*, CaS) does not act merely as a solvent for the Samarium, but that the phosphorescence is related to the special chemical nature of the "centres," which are regarded as a complex molecule. In

developing the idea a comparison table is given showing that the heats of reaction, such as Mg + S → MgS, follow the same course from metal to metal in the group as the shift of similar bands referred to above.
J. E.

1569. *Thermodynamics and Statistics of the Quantum Process.* (*Report on the Question of the Intensity of Spectrum Lines.*) **W. Heitler.** (Zeits. f. Physik, 36. 2. pp. 101–119, 1926.)—In the thermodynamic treatment of radiation equilibrium the equation for mass effect was used, whereby the radiation functioned as a definite chemical body, in which the concentration was taken in the case of "rare" radiation as the density in the phase space, and in the case of concentrated radiation as the known "active" phase density. In the statistical treatment it is shown by a method due to Bose that the process can be built up as a statistical process analogous to the statistics of condition, etc. An expression can thus be deduced for the "thermodynamical probability" of the process in both classical and Bose statistics. The condition of equilibrium affords, primarily, the statistical basis for the final conclusion. The expression for the thermodynamical probability of the process is used for the elucidation of the question of the intensity of spectrum lines. It affords a means of comparison of the intensity of two different series in accordance with experimental values. Finally, it is shown that by means of the Bose statistics the summation rule can hold, which is impossible by means of the classical statistics.
S. G. B.

1570. *The Determination of the Absorption Coefficient for High Radiation.* **W. Kolhörster.** (Zeits. f. Physik, 36. 2. pp. 147–149, 1926.)—A comparison in tabular form and a brief note of the consequences accruing from the observations of various observers for the value of the absorption coefficients for high radiation at various heights from 0 to 9300 metres.
S. G. B.

1571. *On the Magnitude of the Terms of Special Series.* **A. Unsöld.** (Zeits. f. Physik, 36. 2. pp. 92–100, 1926.)—The quantum defect of the non-penetrated orbits may be calculated on the basis that the light electron induces a dipole in the body of the atom. The possible polarisation of the atom may be calculated on the classical dispersion theory. The number of dispersion electrons assumed are, one for the alkaline earths, two for the earths, and three for the alkali metals [see also Abstract 2364 (1923)]. Tables are given showing a comparison between the observed and calculated Rydberg corrections.
J. E.

1572. *Doublet Spectra and the Correspondence Principle.* **J. Kudar.** (Phys. Zeits. 27. pp. 107–111, March 1, 1926.)—The separations of the X-ray and optical doublets can be represented most accurately by the relativity formula, although the separations are more probably due to magnetic causes [see Abstract 2503 (1924)]. The relativity theory leads to an incorrect selection principle. The theory based on different spatial orientations of the orbit of the valence electron gives an empirically valid selection principle, but so far gives an incorrect formula for the doublet separations. Considering a particular case, we can say for Li that

$$\Delta\nu_{\mathrm{rel.}} \mathrel{\hat{=}} \int_{k-1}^{k} \Delta\nu_{\mathrm{mag.}}\, dK$$

where $\Delta\nu_{\text{rel.}}$ and $\Delta\nu_{\text{mag.}}$ are the separations calculated from relativity and from magnetic considerations, k and $(k-1)$ are the azimuthal quantum numbers of the two elliptic orbits, and K is the azimuthal quantum number of the valence-electron. Thus the actually observed separations are connected by an extended correspondence principle with those to be expected magnetically, and these in turn with the separations to be expected classically :

$$\Delta\nu_{\text{class.}} \longrightarrow \Delta\nu_{\text{mag.}} \longrightarrow \Delta\nu_{\text{rel.}}$$

Therefore we may take our selection principle from the magnetic (orientation) theory, and say that combinations forbidden by this theory will also be not expected on the relativity theory, *i.e.* in practice. A. C. M.

1573. *The Intensity Rule of Burger and Dorgelo.* **A. Filippov.** (Zeits. f. Physik, 36. 6. pp. 477–480, 1926.)—The intensity rule of Burger and Dorgelo referring to the relative intensities of the components of doublets of the alkali series is not in accord with results relating to the blue doublet of cæsium λλ4555, 4593 Å. The results are in agreement with those of Roschdestwensky, who found the relative intensities in the ratio 4 : 1 in place of the 2 : 1 ratio required by the rule. It is suggested that the intensity ratio depends upon the principal quantum number, increasing with an increase of this number. J. S. G. T.

1574. *The Intensity Problem of Spectral Lines.* **H. Hönl.** (Ann. d. Physik, 79. 4. pp. 273–323, March 13, 1926.)—The intensity problem of spectral lines has been placed on a new footing by the discovery of the Burger-Dorgelo sum rules which replace the qualitative correspondence principle predictions previously in use. The present paper (which is throughout mathematical and unsuitable for detailed abstraction) is an attempt to discuss the intensity problem of Zeeman components, multiplets, and band lines from a single standpoint. It proceeds from the assumption that the intensities of individual lines not only stand to each other in simple numerical relationships, but may also be expressed as rational integral functions of quantum numbers. Deductions of intensity formulæ for multiplets are made. Further consideration is given to certain general considerations of König on the validity of the intensity formulæ and their extension to term systems, in particular that of the Ne spectra.

The chief new results given in the paper are : (1) Deductions concerning the intensity of Zeeman components concerned in the resonance radiation of an atom in a magnetic field and possible experimental evidence on the matter as derived from previous results on neon ; (2) an expression for the intensity of Zeeman components which is symmetrical with respect to the quantum numbers of original and final states. W. V. M.

1575. *Duration of Emission of Monochromatic Radiations and the Mean Life of the Stationary States.* **A. Pontremoli.** (Accad. Lincei, Atti, 3. pp. 149–154, Feb. 7, 1926.)—Referring to the investigations of Mie [Abstract 1152 (1924)], Eldridge [Abstract 83 (1925)], Wien [Abstract 1185 (1925)], the author proposes to indicate a method of calculating the duration of emission in the most simple case of the passage between two circular orbits. In the case of the passage between elliptical or elliptical and circular orbits the problem becomes more complex because the electron may leave and rejoin the stationary orbit at any point between aphelion and perihelion. We must get a mean duration of emission, determined on the basis of the probability that the electron leaves the stationary state at various points of the trajectory. We can, however, fix the superior limit of the duration of emission between elliptical and circular orbits by supposing that the electron begins to irradiate at aphelion and considering, for each line, the passage between the most eccentric and the circular orbit. The treatment is entirely mathematical.

E. F.

1576. *Polarisation of Radiation scattered by an Electronic System in a Magnetic Field.* **G. Breit.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 195–205, March, 1926.)—The polarisation of radiation scattered by an electronic system in a magnetic field is worked out on the classical theory. It is shown that it is improbable that the experimental facts can be accounted for on a classical analogy. Instead, a quantum hypothesis is made which appears to account for the phenomena more satisfactorily.

AUTHOR.

1577. *The Zeeman-Effect for the Spectrum of Fluorine.* **G. H. Carragan.** (Astrophys. J. 63. pp. 145–159, April, 1926.)—An electromagnet has been constructed which proves to be suitable for the study of the Zeeman-effect at high field-strengths. Certain improvements in the technique of handling fluorine have been instituted and a form of discharge-tube has been devised which is suitable for giving the fluorine spectrum under high field-strengths. The red spectrum has been photographed with a grating of high dispersion and the Zeeman patterns of twenty of the brighter lines determined. The analysis of the patterns with a consideration of the ratios of the intervals of wave-number between the lines and the distribution of their relative intensities seems to indicate a first-order quartet system. On this basis the term combinations of the principal and diffuse series have been located. Those of other lines have been proposed from a consideration of the relationships of the intervals of wave-number and the possible existence of the fluorine ion and higher-order spectra suggested. Four fluorine lines observed by Gale and Monk, but not given in their published list of wave-lengths, are cited. Three of these have been observed and a fourth inferred from the analysis of the spectrum.

AUTHOR.

1578. *Observations on the Stark-Effect of Second Order.* **J. S. Foster.** (Astrophys. J. 63. pp. 191–195, April, 1926.)—The observed average second-order Stark-effect for six perpendicular components of Hδ in a field of 65 kv./cm. is 0·40 Å. On the same plate the central perpendicular component of Hε is displaced 0·73 Å. The shifts calculated from the Epstein formula are 0·30 and 0·79 Å. respectively. The central perpendicular component of the so-called parhelium group including λ4009 (comparable in a sense to Hε) is displaced towards the red 0·35 Å. in a field of 60 kv./cm. No Doppler-effect is found for neutral helium lines from a hydrogen-and-helium-gas mixture in a field of 50 kv./cm. As the Balmer lines were not so tested, it is still possible that the characteristic haze which surrounds their Stark components may be due to light from a comparatively small number of atoms which have gained high velocities as positive ions. According to the present data, the agreement between calculated and observed effects of the second order in hydrogen improves with increasing order.

AUTHOR.

1579. *Intensities in the Satellites of Hg $2p_i - 2s$.* **J. L. Snoek, Jr.** (Zeits. f. Physik, 35. 11–12. pp. 883–887, 1926.)—The intensities of the satellites and the principal lines of this triplet were measured under different conditions of excitation. The light was passed through a monochromator and an echelon grating; to control the intensity a screen could be introduced before the echelon grating. The variation of the current produces no measurable change in the relative intensities of the satellites among themselves, but an increase in current produces a marked decrease in the intensity of the satellite compared with that of the principal line. A comparison of sources showed that the Cooper-Hewitt lamp and the Lummer-Gehrcke lamp were not as good for the purpose as a very thin capillary, since self-reversal upset the intensities. A. C. M.

1580. *On the Classification of the Flame Band-Spectra of Chemical Substances.* **R. Eisenschitz** and **A. Reis.** (Zeits. f. Physik, 36. 6. pp. 414–425, 1926.)—From a study of the influence of the oxygen content and the salt-vapour concentration on the emission of band-spectra in coloured flames, it is concluded that to a high degree of probability (1) the flame spectrum of copper consists of two spectra, which are due to oxygen and oxygen-free carriers respectively. The red and green calcium bands are due to oxygen-free carriers and the iron bands to oxygen carriers. The carriers of the calcium bands contain an atom of calcium in the molecule and the carriers of both copper spectra an atom of copper. (2) The oxygen pressure for the vapours of calcium and copper oxides at 1800° C. lies between 10^{-4} and 10^{-3} atmos., corresponding to half-dissociation. Experimental details with curves and photographs are included. H. H. Ho.

1581. *Quantum Theory of Absorbtion Spectra of Permanganate Solutions and the Influence of the Solvent.* **E. Adinolfi.** (Accad. Lincei, Atti, 3. pp. 196–201, Feb. 21, 1926.)—The absorbtion curves of permanganate solutions in water and alcohol show a regular series of maxima. Applying the quantum conditions assuming rotation and oscillation, values for the moment of inertia and radius of gyration of the group MnO_4 are obtained. The order of magnitude of the moment of inertia is 10^{-42}. These values are small compared to those indicated by data concerned with gaseous material, and it is suggested that the internal pressure of the solvent forces the atoms closer together. Passing from aqueous to alcoholic solutions, this theory indicates that the pressure falls from 10,700 to 2400 atmos. The moment of inertia also falls with lowered temperature of the solutions, and this also may be explained as due to the increased pressure. A. Wh.

1582. *Band Series in Infra-red Absorption Spectra of Organic Compounds. I.* **J. W. Ellis.** (Phys. Rev. 27. pp. 298–313, March, 1926.)—The frequencies of a series of outstanding absorption bands characteristic of organic liquids, previously attributed by the author to vibrations between atoms of a carbon-hydrogen pair, are shown to fit the equation $\nu_n \,.\, 10^{-12} = 47 \cdot 37n - 0 \cdot 783n^2$, where $n = 1, 2, \ldots 10$. Many of the bands of secondary intensity in the spectra of compounds containing a carbon-carbon bond have their frequencies expressed by $\nu'_n \,.\, 10^{-12} = 10 \cdot 71n$, where $n = 1, 2, \ldots 28$. Practically all other bands observed below 7 μ in such spectra can be accounted for by combinations of low-frequency members of these two series, $\nu_c = \nu_m + \nu_n'$. Measurements on bands occurring between 2μ and 3μ were made from records obtained with a new registering spectrograph. Several such spectra are shown. AUTHOR.

1583. *Absorption Spectra of Some Gases and Vapours in the Schumann Region.* **S. W. Leifson.** (Astrophys. J. 63. pp. 73–89, March, 1926.)—The absorption in the Schumann region of oxygen, nitrogen, nitrous oxide, nitric oxide, nitrogen peroxide, carbon monoxide, carbon dioxide, hydrogen chloride, ammonia, methane, water (and vapours of water), carbon tetrachloride, and ethyl alcohol has been studied. A vacuum grating spectrograph was used with an absorption cell with fluorite windows built into the discharge-tube. The continuous spectrum of hydrogen in the region λ2000–λ1600 and the secondary spectrum of H from λ1600 to λ1250 served as the background for the absorption spectra. The fluorite windows transmitted the hydrogen line λ1215·67, apparently setting a new ultra-violet limit for the transparency of fluorite. The results of previous investigators on oxygen, nitrogen, carbon monoxide and carbon dioxide have been verified and considerably extended. New data have been obtained for the other gases and vapours. The moment of inertia of the molecule of nitric acid was found to be about $11{\cdot}2 \times 10^{-40}$ g.cm.^{2}. Formulæ are given for the heads of the bands in terms of frequency for O, CO, CO_2, and the vapour of ethyl alcohol. AUTHOR.

1584. *Interferometer Measurements of the Pressure-shift of Lines in the Arc Spectrum of Nickel.* **B. T. Barnes.** (Astrophys. J. 63. pp. 127–132, March, 1926.)—The wave-lengths for 72 lines in the nickel spectrum when emitted by an arc operated at a pressure of 76 cm. of Hg are compared with those at 6 cm. Using a Fabry and Perot etalon, with a concave grating spectrograph for the auxiliary dispersive system, the nickel and the iron spectra were superposed and photographed simultaneously. The latter furnished standard lines from which to compute the nickel wave-lengths. By use of light from only the central region of a 12-mm. arc, errors due to pole-effect were eliminated. Most of the lines measured have a pressure-shift of less than 0·005 Å. per atmos. A few of the strongest lines showed an apparent shift of about 0·03 Å. per atmos. when a 11-mm. etalon was used. On changing to a 6-mm. etalon, the shift measured was much less. Hence it is attributed to an unsymmetrical broadening of the line. This anomaly was found only in the case of very diffuse lines difficult to measure at atmospheric pressure. For the sharper lines, measurements on different plates agreed quite well. The probable error in the wave-lengths in Table I is, in most cases, not over 0·001 Å. AUTHOR.

1585. *Answer to a Criticism by G. Wentzel.* **A. Landé.** (Zeits. f. Physik, 36. 4. p. 276, 1926.)—A short note in answer to [Abstract 543 (1926)]. W. V. M.

1586. *Distribution of Energy between the Modified and the Unmodified Rays in the Compton-Effect.* **Y. H. Woo.** (Phys. Rev. 27. pp. 119–129, Feb., 1926.)—Using small tubes of the Compton type and Soller collimators, reliable measurements of the intensity of scattered X-rays were obtained from five radiators—paraffin, wood, carbon (graphite), aluminium and sulphur. An ionisation spectrometer (ethyl bromide) with a large calcite crystal was employed. Since the wave-length range investigated was small, the relative energy of each spectrum was obtained, to a close approximation, by integrating with a planimeter the area under the ionisation curve which represented the line. The results of this measurement are as follows :—

ϕ.	R (paraffin).	R (wood).	R (carbon).	R (aluminium).	R (sulphur).
60°	2·29	1·19	1·08	0·46	—
75°	3·10	1·85	1·31	0·74	0·25
90°	4·69	2·73	1·45	0·91	0·42
105°	5·16	3·21	1·82	1·23	0·67
120°	5·49	4·57	2·26	1·45	—
135°	6·52	5·38	3·42	2·11	—
150°	6·98	6·21	4·05	2·52	—
165°	7·47	7·00	4·86	—	—

where ϕ represents the scattering angle and R the intensity ratio of the modified to the unmodified line. The values of R increase with the angle of scattering for a given element in the general manner predicted by Jauncey's theory, but the numerical values given by the theory are 20 to 50 % too large. For a given angle, the values of R increase as the atomic number decreases, being greatest for paraffin which contains relatively more hydrogen than does wood. Experiments were also performed with a lithium radiator kept in a lead cell filled with hydrogen, on which two mica windows (about 0·005 mm. in thickness) were provided so that one of them allowed the primary ray to fall on the scatterer and the other permitted the secondary ray to pass into the collimator. With a scattering angle of 110°, the unmodified line was practically absent—certainly less than 4 % of the modified. This seems to prove that the Compton-effect cannot be attributed to anything other than true scattering. This also favours the hypothesis, suggested by A. H. Compton, that the unmodified line occurs when the energy imparted to the electron during the process of scattering is insufficient to eject it from the atom.

AUTHOR.

1587. *Some Properties of Compton Radiation.* **H. Kallmann** and **H. Mark.** (Zeits. f. Physik, 36. 2. pp. 120–142, 1926.)—An investigation, both theoretical and experimental, of some particular properties of the altered component of scattered X-radiation, with particular reference to the vibration, phase relationships and intensity as functions of angle of scattering, nature of the scatterer and wave-length of the original radiation. If a quantum falls on an atom, two processes of scattering and emission of photoelectrons take place, the results of the scattering differing according to whether a crystal or a single atom is considered. In all cases the direction of polarisation of the primary beam is conserved in the scattered radiation. An experimental investigation of this point, using ZnKα reflected from the (440) plane of NaCl after scattering from lithium (the wave-length and spacing are chosen so as to allow of observations being made at a diffracting angle of 90°), shows that the ratio of modified to unmodified line is independent of the angle of observation in a plane perpendicular to the scattered radiation, and hence the degree of polarisation of the Compton component is the same as that of the original radiation. A powder photograph of ZnKα scattered by lithium shows that the usual " coherence " between the elementary waves scattered from crystal atoms is not present in the Compton modified radiation, no maxima in intensity being observed as due to it. This fact is linked with the observation that the Compton scattering process applies to "free" electrons only.

The intensity problem is discussed from various standpoints. The Compton equations hold for "free" electrons—*i.e.* those for which the quantum is greater than the work required to remove the electron from its orbit—while for smaller quanta, specific effects appear depending on the ratio T/E, where T is the energy transferred to a free electron by scattering of the incident quantum through a given angle and E the work of ionisation. It is considered that a broadening of the modified line occurs when the ratio approximates to unity. This ratio T/E also plays an important part in the question of the ratio of modified to unmodified intensity as dependent on the atomic number of the scatterer, and the work of Davies and Ross is discussed from this standpoint. Again, for varying λ of incident radiation similar results are indicated, but experimental investigation is difficult owing to the usual non-homogeneity of the primary radiation. W. V. M.

1588. *Intensity Measurements of X-radiation using a Geiger Counter.* **A. Jōnsson.** (Zeits. f. Physik, 36. 6. pp. 426–456, 1926.)—For theoretical atomic considerations a knowledge of the relative intensities of spectral lines is of primary importance, and recently photographic methods have been employed (Dorgelo and his co-workers) to determine certain relative values. There are, however, considerable theoretical and practical difficulties in this method as well as in the ordinary ionisation method of measurement, the latter arising from wall effects and varying absorption with varying wave-length. The theoretical best method would be the rise of temperature owing to the complete absorption of the radiation. The Geiger counter can evidently be adapted to count the number of quanta, and hence the intensity of an X-radiation. The author has therefore replaced the photographic plate of the Siegbahn precision spectrograph by such a counter, using a direct deflection method with a quadrant electrometer, the point of the counter being raised to potentials varying from 1400 to 2000 volts. Details of the arrangement are given as well as precautions to be taken with the point, such as the control of humidity of the air and the presence of dust. Curves showing the variation of number of quanta reaching the counter in a given time, and hence the relative intensities of $\mathrm{CuK}\alpha_1$ and $\mathrm{K}\alpha_2$ are given in both first and second order, and it is shown that the ratio of the maximum deflections (taken as measures of the intensities) are fairly accurately in the ratio of 2 : 1. Observations are also made on the minimum voltage required to cause the appearance of the L lines of tungsten and found to be in good agreement with the formula $V = \frac{12\cdot 34 \text{ kv.}}{\lambda \text{ Å.U.}}$. The variation in the intensity of L lines with increasing voltage follows the Webster-Clark $(\nu - \nu_0)^{3/2}$ law. Davis has shown theoretically that a law of the form $J = C(\nu - \nu_0)^n$ is to be expected, and n is found to vary between 1·5 and 2, values of 1·9 being obtained for $\mathrm{CuK}\alpha_1$ and 1·7 for the L lines of W and Pt. Relative intensities of the L series of W and Pt were also investigated. An interesting observation is the superior sensitiveness of the counter as the wave-length of the radiation crosses the L_{III} limit of Pt, a small amount of this metal being struck by the rays in the counter. The counter is more sensitive on the short than on the long wave side of PtL_{III}. The observed relative intensities are corrected for absorption in aluminium windows and air, and finally fairly good agreement is reached with the Burger-Dorgelo sum rules. Thus for $K\alpha_1 : K\alpha_2$ the expected 2 : 1 is obtained. Other L lines show agreement, but there are some outstanding discrepancies, though simple numerical relationships are still obtained. Thus $\beta_3 : \beta_4$ is given as having the ratio 3 : 2 instead of 2 : 1. The Dorgelo rules appear to hold for the X-ray lines corresponding to transitions ending in L_{II} and L_{III}, but not for those ending in L_I. In an addendum to the paper it is pointed out that other observers have found relative intensities of 2 : 1 for $\beta_3 : \beta_4$, but these results are uncorrected for absorption. For detailed results the paper should be consulted. W. V. M.

1589. *Resonance Absorption of X-Rays.* **V. Posejpal.** (Comptes Rendus, 182. pp. 767–769, March 22, 1926.)—A comparison of the absorption of the $K\alpha_1$ and $K\alpha_2$ rays of tungsten in tungsten and in copper foil. A photographic method is used, and intensities are measured by means of a microphotometer. The absorption coefficients obtained experimentally are compared with those predicted by the Bragg-Peirce formula.

W. H. Ge.

1590. *Theory of X-Ray Reflection.* **I. Waller.** (Ann. d. Physik, 79. 3. pp. 261–272, March 8, 1926.)—Ewald has already shown [Abstract 1397 (1925)] that the intensity of reflection for a given line is for a large perfect crystal proportional to the structure factor. Darwin has also shown [Abstract 1618 (1922)] that, regarding a large imperfect crystal as a mosaic of minute ones, the same intensity law holds as for each minute crystal, namely the intensity proportional to the *square* of the structure factor. The present investigation is based on a previous formula of the writer's for reflection from a perfect crystal. The value of the reflected energy is calculated for an ideal plane parallel rotating crystal plate for any position of the net plane with respect to the plate face. The relation of the intensity to the structure factor can be very different according to this position. It is shown that in general if the micro-crystals are extremely small the formula leads to the same result as the Laue theory —with intensity proportional to the square of the structure factor. If, on the other hand, the crystals are not very small, the reflected energy is proportional to the first power of the structure factor. J. E.

1591. *Absorption of X-Rays of Wave-length down to* 0·08 Å. **S. J. M. Allen.** (Phys. Rev. 27. pp. 266–276, March, 1926.)—Mass absorption coefficients of C, paraffin, S and sixteen metal elements from Al to U for wave-lengths 0·56 to 0·08 Å. have been measured in continuation of previous work [see Abstract 2278 (1924)] which covered most of these elements in the range 0·71 to 0·10 Å. The general radiation from a tungsten target (operated at voltages up to 200 kv.) was dispersed by a crystal into an ionisation chamber. By using Soller multiple-slit collimators about ten times as great intensity was obtained as with a single slit of the same resolving power. The main results of the previous paper were confirmed and extended, especially the steady decrease in the "jump" of the absorption in going from the L to the K regions, as the atomic number increases. The scattering of paraffin wax is distinctly greater than that of C or Al, probably due to the richness of H in paraffin. The empirical formula $\mu/\rho = C\lambda^{2\cdot 92}N^4/A + \sigma/\rho$, applied to the experimental results, gives values of σ/ρ which increase in general with atomic number, becoming about 1 for the heavier elements, W to Bi. The values of C obtained are 0·0132 for the K-series and 0·00181 for the L-series; these give calculated values which agree within 5 % with the experimental. Without collimators or crystal, the ionisation chamber in the path of the direct beam of rays filtered through 1 cm. tin and 2 cm. aluminium showed increased ionisation when a carbon block was interposed, but when two Soller collimators were used, with planes crossed so as to eliminate all oblique rays, normal absorption coefficients were obtained corresponding to 0·075 Å. This method may be useful for the shortest rays. AUTHOR.

1592. *X-Ray Studies of Some Metallic Alloys (the Series Au-Ag and NiCu).* **S. Holgersson.** (Ann. d. Physik, 79. 1. pp. 35–54, Feb., 1926).—The material was used in the form of a wire in a Debye-Scherrer camera, the source of rays being a Hadding-Siegbahn tube [Abstract 932 (1921)] with iron antikathode (sometimes copper). Corrections were introduced for the thickness of the sample. Data and correction tables are given for the pure metals. The results on the AuAg series do not agree with McKeehan [see Abstract 287 (1923)], whose curves, showing lattice parameter against atomic composition, confirm the Tammann resistance limit theory. The writer's curves approximate to the more general type, where the lattice constant is approximately proportional to the concentration of one constituent. The CuLi series show a slightly bent atomic per cent.-parameter curve. In a review of the properties of alloys (*e.g.* thermal and electrical conductivities, etc.) in the light of the electron theory, the writer suggests an explanation of the lowering of conductivity and departure from the Wiedemann-Franz law in alloys. The X-ray studies show that the contraction brought about by the addition of one metal follows the same course as the conductivity curves. This suggests the explanation that the diminution of atomic distance increases the restraining forces on the free electrons and so diminishes conductivity; also this effect is greater on the slower electrons, so that the heat conductivity will not be lowered as much as the electrical conductivity. J. E.

1593. *K Critical Potential of Light Atoms.* **F. Holweck.** (Comptes Rendus, 182. pp. 779–781, March 22, 1926.)—Extends the work of previous papers [see Abstract 1053 (1926)] and deals with oxygen, nitrogen, NO_2 and BH_3. The discontinuities are found to have a fine structure, and the results are shown graphically. The note concludes with a reply to a criticism by **A. Dauvillier.** W. H. GE.

RADIO-ACTIVITY.

1594. *Action of the Radiation from Mesothorium on Selenium.* **W. del Regno.** (Accad. Lincei, Atti, 3. pp. 201–205, Feb. 21, 1926.)—By determining the effect on the electrical resistance of a selenium cell of a capsule of mesothorium, both with and without the intervention of a thin lead screen, it is shown that the greater part of the effect is due to the β-rays, but that the γ-rays also have an action. The effect of distance on the sensibility and on the relation between time of exposure and change in resistance is also shown in graphs and tables. A. Wh.

1595. *An Electrometer for studying Weak Radio-active Manifestations.* **A. Nodon.** (Comptes Rendus, 182. pp. 457–458, Feb. 15, 1926.)—Describes an instrument with very small electrostatic capacity, in which the minute metallic parts are insulated by a support of roughened quartz. The small moving aluminium leaf is observed with a small telescope with a micrometer scale. The electrometer can be used in studying radio-active phenomena of small intensity, such as those which the author considers are produced by living cells and by solar radiations. H. N. A.

1596. *The Disintegration of Aluminium by α-Rays.* **E. A. W. Schmidt.** (Akad. Wiss. Wien, Ber. 134. 2a. No. 7–8. pp. 385–404, 1925.)—Describes an apparatus, based on that of H. Pettersson, using a ring-formed preparation of RaC or polonium arranged in such a manner that the H-particles sent out from aluminium plates of different thickness at an average angle of 150° produce scintillations on the screen. α-rays of natural and of reduced range were employed, and it was found that the number of H-particles exceeded by more than one order of magnitude that found by Rutherford and Chadwick for particles sent out at an angle of 90°, being 80 per 10^6 primary rays, using the full range of RaC. A large number of H-rays were given off when α-rays of 1 to 2 cm. range were employed, while Rutherford and Chadwick found none when the α-ray range was less than 4·9 cm., and have used this fact in developing their theory of atomic disintegration and structure. In the angular region examined no minimum range of the H-rays produced by α-particles of different velocities has been shown to exist. The small number of experiments carried out with polonium as the α-ray source show that it is particularly suitable for quantitative determinations, and confirm the results obtained using RaC. H. N. A.

1597. *Spectrography of Gamma-Rays. Spectra of Secondary β-Rays and Crystalline Diffraction.* **J. Thibaud.** (Ann. de Physique, 5. pp. 73–152, Jan.–Feb., 1926.)—Investigation of monochromatic γ-rays of high frequency presents very great difficulties. Consequently the author has studied these radiations indirectly, the secondary β-rays excited by the γ-rays photoelectrically in matter. For this purpose a special spectrograph of high precision has been constructed. As a first result the accuracy of the Einstein photoelectric law has been verified in the region of high frequencies. Secondly, the identity has been established between the β-ray spectrum excited in the isotopic element of an active substance and the *natural* β-ray spectrum of the same substance, thus demonstrating the secondary origin of natural β-ray spectra. The whole series of penetrating γ-rays, between 100,000 and 2,000,000 volts, has been measured and classified in spectra of characteristic γ-rays from ThB, RaC, MesTh 2, ThB and ThC. The method of crystalline diffraction has been used as a means of comparison in the region of wave-lengths where it was possible to employ it. A. B. W.

1598. *The Retardation of β-Rays by Matter.* **J. d'Espine.** (Comptes Rendus, 182. pp. 458–460, Feb. 15, 1926.)—The author has studied the retardation of the β-rays of RaB, RaC and ThB by screens of different thicknesses and different materials. His results are very similar to those obtained by Danysz and recently by Thibaud. A table gives the diminution, $\Delta(H\rho)$, of $H\rho$ for eleven lines of the magnetic spectra of the above elements, produced by a thickness of screen weighing 0·01 g. per sq. cm.; this diminution is independent of the material of the screen. The actual diminution of $H\rho$ for a screen of any material is proportional to the thickness up to a certain limit. H. N. A.

HEAT.

1599. *The Effects of Torsion upon the Thermal and Electrical Conductivities of Aluminium, with Special Reference to Single Crystals.* **J. E. Calthrop.** (Phys. Soc., Proc. 38. pp. 207–213; Disc., 213, April, 1926.)—An attempt has been made to find the changes produced by torsion in the conductivities of single aluminium crystals, and of the annealed and hard aluminium wires from which the crystals are prepared. The hard wire gave a decrease of a few parts in a thousand in the thermal conductivity, but no change greater than 1 part in 1000 has been found in crystal wires. The decreases in the electrical conductivities, of the order of a few parts in 10,000, appear to be almost the same for all specimens. AUTHOR.

1600. *On the Evaporative Losses of Vacuum-jacketed Vessels of the Dewar Type.* **R. M. Archer.** (Phys. Soc., Proc. 38. pp. 247–271; Disc., 271–272, April, 1926.)—In this paper the evaporative losses of metal Dewar vessels are discussed, and particulars given of experiments made by the author in the Oxygen Laboratory of the Air Ministry. The separation of neck and radiation losses is described, and also a method of testing adsorbents under working conditions. Experimental details are given with graphs and tables. AUTHOR.

1601. *The Evacuation of Carbon Dioxide and Water.* **N. R. Campbell.** (Phil. Mag. 1. pp. 762–768, April, 1926.)—When a cooled trap is used for removing mercury-vapour, there is a danger that substances may condense in the trap and establish in the vessel to be evacuated a pressure large enough to be appreciable, yet small enough to prevent the rapid removal of the substance by the pump. If the trap is cooled in liquid oxygen boiling at atmospheric pressure, carbon dioxide condenses in this manner; if solid CO_2 is used, water condenses. Accordingly if these substances are present and a pressure is to be obtained as low as that possible in their absence, the trap must be maintained at some other temperature. It can easily be maintained (1) at 78° K. by boiling the oxygen under reduced pressure, or (2) between 108° and 150° K. by means of solid mercury cooled by liquid oxygen. At either of these temperatures pressures less than 10^{-7} mm. can be obtained quickly, even if water and carbon dioxide are present. The vapour-pressure of CO_2 at 90°·2 K. is a convenient standard for calibrating ionisation gauges. AUTHOR.

1602. *Annealing and Re-annealing of Glass.* **W. M. Hampton.** (Optical Soc., Trans. 27. 3. pp. 161–179; Disc., 179–180, 1925–1926.)—The formulæ deduced in the previous paper [see Abstract 1135 (1925)] are applied to the case of heating glass under constant gradient, and the temperature at which strain disappears is obtained, the effect of the known change in the coefficient of expansion on this temperature being discussed. The calculated and experimental curves are compared and the effect of changes in the rate of heating and in the size of the specimens is considered. The annealing equation is considered from the point of view of dimensions. The agreement of theory and experiment is discussed, and an explanation of the discrepancies at low temperatures is advanced. A general expression to cover all cases is deduced, and the results of theory and experiment are compared. AUTHOR.

1603. *The Present Status of Theory and Experiment relating to Specific Heats and the Chemical Constant.* **F. I. G. Rawlins.** (Phys. Soc., Proc. 38. pp. 176–191; Disc., 191–192, April, 1926.)—The theoretical and experimental aspects of the specific heats of solids, liquids and gases in the light of present knowledge are discussed. Possible lines of advance have been indicated for solids in view of the progress now being made in X-ray crystallography, and the importance of further experimental work on compressibilities and elastic constants is suggested. Tentative views on the specific heat of liquids are given. In gases the quantum theory of rotational heat is shown to fail to account satisfactorily for the behaviour of hydrogen at low temperatures. The chemical constant of monatomic and diatomic substances is discussed, both from a thermodynamic and from a statistical point of view. Current views on the nature of this constant are described. The theory of gaseous degeneracy and its bearing upon specific heats and chemical constants is reviewed. AUTHOR.

1604. *Critical Discussion of the Determinations of the Mechanical Equivalent of Heat.* **T. H. Laby.** (Phys. Soc., Proc. 38. pp. 169–172; Disc., 172–175, April, 1926.)—The principal recorded determinations of the mechanical equivalent of heat are critically discussed, and an attempt is made to correct them for errors not fully taken into account at the time when they were made. The results are weighted according to the relative importance attached to them by the author, and the weighted mean is given as 4·184 joules per calorie at 20°. AUTHOR.

1605. *Internal Pressure and Free Space in Fluids.* **W. Herz.** (Zeits. Elektrochem. 32. pp. 210–213, April, 1926.)—The internal pressure B can be calculated in atmospheres (after Stefan) from $B = (L42700/2V1033)$, where L is the heat of vaporisation and V the volume of unit mass. The free space V_f (not taken up by the molecules) of the author is the difference between the molecular volume at a given temperature and the volume at absolute zero [Abstract 796 (1920)]: $V_f = M/d - M/d_0$. The author's calculations for pentane, hexane, etc., methylformate, etc., alcohols, the tehrachlorides of carbon and tin, ammonia, water, oxygen and nitrogen show that the internal pressures decrease and the free spaces increase as the temperature is raised. For many materials these relations are regular within a large range, so that the product BV_f is fairly constant. Near the critical temperature the internal pressures decrease more rapidly than the free spaces increase. In homologous compounds the B decrease and the V_f increase with increasing molecular weight. H. B.

1606. *A Special Case of a "Stationary" Flow of Liquid arising from Heat Convection.* **B. Gündel.** (Zeits. Math. u. Mechanik, 6. pp. 112–117, April, 1926.)—A mathematical paper giving the solution of a peculiar case of liquid flow to which the author was led in Abstract 1398 (1926). It is the case of "stationary" liquid flow between two vertical parallel walls at a given distance apart, each wall being maintained at definite temperatures which are a linear function of the height and in such a way that there is a difference of temperature between two points on the two walls which are at the same height. The paper is unsuited to a brief abstract.

T. B.

1607. *Calculation of Heat Transmission by Irradiation.* **U. Bordoni.** (Elettrotecnica, 13. pp. 213–219, April 5, 1926.)—The paper is entirely mathematical, and treats of the following subjects: Emission of the "black body." Emission of the most common surfaces. Law of the exchange of energy between a body and its surrounding medium. Exchange of radiant energy between two surfaces in close proximity. E. F.

1608. *Entropy of Radiation.* **M. Saha and R. K. Sur.** (Phil. Mag. 1. pp. 890–893, April, 1926.)—The thermodynamical probability, W, of a system is given by the equation $W = \{\gamma\}/\{\gamma\}_0$, in which $\{\gamma\}$ and $\{\gamma\}_0$ are respectively the phase-space described by the system at T_0 and absolute zero [see Abstract 1073 (1926)]. This formula is applied to deduce the absolute value of the entropy of radiation of frequency between ν and $\nu + d\nu$ in the form $S_\nu d\nu = d\nu \,.\, K \,.\, \log\{(A_\nu + N_\nu)!/A_\nu!N_\nu!\}$, in which A_ν denotes the number of ways a quantum of frequency ν can be contained within unit volume, whilst N_ν is the number of energy elements concerned.

J. S. G. T.

1609. *Quantisation of the Monatomic Perfect Gas.* **E. Fermi.** (Accad. Lincei, Atti, 3. pp. 145–149, Feb. 7, 1926.)—The author's object is to demonstrate a method of quantising a perfect gas which does not depend on hypotheses concerning the statistic behaviour of its molecules. Numerous attempts have recently been made to establish the equation of state of a perfect gas. [See Abstracts 1439, 1440 (1925).] The various formulæ differ from each other and from the classical equation only for very low temperatures and very high densities. But that is where the deviations of the laws of real from those of perfect gases are most marked, and as, under experimental conditions, the deviations from the equation of state $pV = kT$, due to the degeneration of the gas, are, though not negligible, always somewhat less than those due to the fact that the gas is real and not perfect, the former have hitherto been masked by the latter. With a more complete knowledge of the forces acting between the molecules of a real gas it may be possible to separate the two deviations, and thus decide experimentally between the various theories of the degeneration of perfect gases. In order to quantise the molecular motion of a perfect gas, Sommerfeld's rules, subjecting the molecules to a system of forces such that their motion becomes periodic and thus quantisable, must be applicable. But to calculate systems containing elements not distinguishable from each other, Sommerfeld's rules need to be supplemented. For the choice of a hypothesis the behaviour of the heaviest hydrogen atoms, all containing more than one electron, must be examined. In the deep portions of a heavy atom the forces acting between the electrons are very small compared with those exercised by the nucleus. Sommerfeld's rules here lead to the conclusion that in the normal state of the atom many of the electrons would be situated in an orbit of a total quantum 1. Observation shows, however, that the ring K is saturated when it contains two, ring L when it contains eight electrons, etc. This fact has been interpreted by Stoner [Abstract 38 (1925)] and Pauli [Abstract 1875 (1925)].

The atom cannot thus contain two electrons whose orbits are characterised by the same quantum numbers, *i.e.* an electronic orbit is "occupied" when it contains one electron. Applying a similar hypothesis to the quantisation of a perfect gas containing at most one molecule whose motion is characterised by certain quantum numbers, the author proposes to show that it leads to a perfectly consistent theory of such quantisation, accounting for the reduction of the specific heat at low temperatures and leading to the exact value for the constant of entropy. Full mathematical details are reserved for a future paper. E. F.

1610. *Relations between the Temperatures, Pressures and Densities of Gases.* **S. F. Pickering.** (Bureau of Standards, Circ. No. 279 [85 pp.], 1926.)—The attempt has been made in discussing the relations between the temperatures, pressures, volumes and weights of gases to derive the formulæ in a simple manner with the minimum requirements of theoretical knowledge on the part of the reader. The experimental data involving high pressures are presented in such a form that problems of this nature can be easily solved by introducing factors taken directly from curves. The significance of the equations of state of van der Waals, of Dieterici and of Berthelot are discussed, and the manner in which these equations may be used to predict compressibilities is explained in detail. Comparisons of the calculated values with the experimental data for various gases are shown by means of a series of curves. There is included a rather extensive bibliography of the literature pertaining to the subjects discussed, together with a number of tables of conversion factors and equivalents. AUTHOR.

1611. *The Adiabatic Ignition of Hydrocarbon Mixtures.* **A. Pignot.** (Comptes Rendus, 182. pp. 376–377, Feb. 8, 1926.)—The conditions of ignition of mixtures of air and inflammable vapours is of interest theoretically as well as in its practical application to explosion engines. The method which is the most directly interesting is ignition by adiabatic compression, as it lends itself to the most precise measurement. The apparatus employed is based on those of Falk [see Abstract 428 (1908)] and Dixon and Crofts [Abstract 1855 (1914)], where instantaneous compression to a known amount is simply obtained, and ignition detected by a thermo-electric couple. A mixture is characterised by the volumetric contraction necessary to obtain ignition, starting at a given fixed temperature. In studying a particular combustible, experiments were carried out on a series of its mixtures with pure dry air. A system of curves was thus obtained connecting the percentage of combustible with the initial temperature necessary to obtain ignition. In this way hexane, heptane, normal octane, cyclohexane, benzene, toluene, metaxylene, mesitylene, and ethyl alcohol have been tested. With a compression ratio of 9 to 1 absolute ethyl alcohol gave curves very similar to those of benzene. Experiments with substances of known anti-detonant properties, such as toluidene and ethyl sulphide showed a negligible influence on the characteristic curves. T. B.

1612. *On the Equation of State of Solid Substances (Metals) in Connection with their Compressibility and with the Pressure and Temperature Coefficient of this Quantity.* **J. J. van Laar.** (K. Akad. Amsterdam, Proc. 19. I. pp. 95–112, 1926.)—The author first discusses the equation of state for cases where there is a very strong dependence on the volume b and derives the equation $p + a/v^2 = \mathrm{RT}[1 + (b_g - b_0)v]/(v - b_0)$, which renders all the thermal quantities (compressibility, expansibility, etc.) for liquids with great accuracy. For solid substances the equation $p + a/v^2 - b/v^n = \nu\mathrm{RT}/v$, proposed by Grüneisen and others, is shown to be incorrect, whereas if $p + a/v^2 = (\lambda + \mathrm{RT})/(v - b)$ be taken, in which b is a function of v, all the discrepancies disappear, and also the discontinuity between the form of the virial of repulsion in liquids and solids. Since in solids the molecules are bound to definite positions of equilibrium, a term λ has to be introduced for the "static" virial of repulsion. It is shown that the above equation, combined with a relation $b = f(v)$, represents the experimental results for metals perfectly accurate in every respect—not only for the coefficients of compressibility and expansibility, but also for their coefficients of pressure and temperature. This the earlier theories of Grüneisen and others were unable to do. The discussion is then extended to higher temperatures, following which come detailed calculations for copper, *viz.* of a/v^2, the coefficients of expansion and compressibility, and the coefficients of pressure and temperature of the compressibility coefficient. The data obtained support the theoretical deductions both with respect to order of magnitude and numerical value. Abstract 2550 (1925) should also be consulted. H. H. Ho.

1613. *A Wave which precedes the Explosive Wave.* **J. Ottenheimer** and **R. Dubois.** (Comptes Rendus, 182. pp. 618–620, March 8, 1926.)—In two recent articles [see Abstracts 332 and 639 (1926)] E. Jouguet studied the mechanism of the explosive wave, and stated that it is preceded by a more rapid propagation, which passes progressively to the explosive wave proper. A comparable phenomenon is now announced by the authors of the present paper. A submarine explosion of melinite was registered by the help of a strongly-damped microphone, of which the undamped frequency was 700 to 1100 per sec., with a very moderate amplification. The charge was detonated at a distance of 700 metres from the instruments. The oscillogram, of which a reproduction is given, shows a wave of compression with very rigid front, preceded by a "musical" wave of duration about 0·2 sec. After discussing possible explanations of the phenomenon, the authors conclude that the two waves started together with the velocity of detonation of the explosive (of the order of 5500 metres per sec.), but that the velocity of the musical wave fell less rapidly, in relation to that of sound in water (1450 metres per sec.), than the velocity of the explosive wave proper, thus explaining the observed difference of time of their reception. T. B.

SOUND.

1614. *Overtones of Lipped Pipes blown at reduced Air-pressure.* **Z. Carrière.** (J. de Physique et le Radium, 7. pp. 7–12, Jan., 1926.)—Account of a study and a method of photographic representation of the vortices by which the stream of air issuing from the vent of a lipped open pipe is split up when the air-pressure in the wind chest is decreased to zero. The sounds maintained at these feeble pressures are harmonics of the fundamental. For the fundamental *n* there is a single pair of vortices; for the first overtone 2*n* and the second overtone 3*n* there are two and three such pairs respectively. G. A. S.

1615. *Pitch Effect on Vocal Tones of External Pressure applied to a Singer's Throat.* **L. E. Dodd.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 119–130, Feb., 1926.)—Using a phonelescope, it is shown that eight vowel sounds each sounded at two pitches by three different singers experience a drop in pitch when pressure is applied to either the thyroid cartilage or the trachea between the cricoid and the breastbone. Pressure on the cricoid cartilage produces a consistent rise in pitch in every case except for one singer at one pitch where there is either a rise in pitch or no change. G. A. S.

1616. *Anomalous Action of the Rayleigh Disc.* **C. H. Skinner.** (Phys. Rev. 27. pp. 346–350, March, 1926.)—In the case of a disc 15 cm. in diam. in a tube 16 cm. in diam., a study of the deflection as a function of wave-length, 4 to 28 cm., showed that for a wave-length of 28 cm. the disc tended to set itself parallel to the axis of the resonator, and hence was deflected in a direction opposite to the usual one. Other negative maxima were observed for waves of about 14 and 7 cm. Experiments with smaller discs showed that beyond a certain tube length the maximum critical wave-length for a negative maximum is independent of the tube length and depends more on the tube diameter than on the disc diameter, approaching twice the tube diameter as the size of the disc is increased nearly to that of the tube. AUTHOR.

1617. *Telephonic Coupling of Acoustic and Electrical Oscillations.* **C. Barus.** (Nat. Acad. Sci., Proc. 11. pp. 728–732, Dec., 1925.) Some results are given using the "pinhole-probe" described in [Abstract 138 (1926)]. A. C. M.

1618. *Resultant Oscillation Diagrams.* **H. Hecht.** (Elek. Nachrichten, 3. 4. pp. 121–138, 1926.)—Many problems concerned with acoustic and electrical oscillations cannot be solved in a satisfactory manner by a single diagram, especially when the components refer themselves to problems of different characteristics. Examples of such problems are discussed in this paper, which investigates the general theory of the resultant oscillation from the standpoint of the technical application of the theoretical data obtained. The problems dealt with are mainly those involving forced oscillations. § 1 considers the simple oscillation, § 2 the coupling of two oscillations, § 2*a* elastic and capacity coupling, and §3 the combination of more than two oscillations. The paper is mathematical throughout and very comprehensive. H. H. Ho.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1619. *Heaviside's Proof of his Expansion Theorem.* **M. S. Vallarta.** (Am. I.E.E., J. 45. pp. 383–387, April; Disc., 471–472, May, 1926.)—Heaviside's proof of his celebrated Expansion Theorem, found scattered in his "Electrical Papers," is reconstructed. It is based upon his so-called "conjugate theorem," also discovered independently by Routh, which establishes a relation between any two normal modes of oscillation of a dynamical system. Heaviside's argument applies to systems having finite number of degrees of freedom and no repeated or null roots of the determinantal equation of the system. The relation between Heaviside's, Carson's and Wagner's proofs is also pointed out. AUTHOR.

1620. *The Intermittence of Electric Force.* **J. J. Thomson.** (Roy. Soc. Edinburgh. Proc. 46. 1. pp. 90–115, 1925–1926.)—Modern research has apparently furnished a complete specification of the systems which make up the atom, and, if the forces between the electrified constituents follow the usual laws of electrostatics, all the material is to hand for calculating the behaviour of the atom by the laws of dynamics. The behaviour predicted in this way, however, differs in important respects from the actual behaviour of the atom, and the author now attempts to explain the origin of the discrepancy. For this purpose it is supposed that the effects produced by electric forces are intermittent and consist in the addition of finite increments of momentum occurring after finite intervals of time, and not, as is usually assumed, of a continuous flow of momentum. On the latter view, a body in the time δt receives an increment of momentum $F\delta t$, if F is the force; on the new viewpoint it is a chance whether or not the body receives any increment; this chance is equal to $\delta t/T$, where T is a time called the time interval of the force, and depends on the strength of the field being equal to the average time between two increments. If I is the value of each increment of momentum, the expectation of increase of momentum in time δt is $I\delta t/T$. Over intervals which are long compared with the time T, the increase is the same as that under a continuous force equal to I/T, and for effects which are spread over such intervals the results of the intermittent theory agree with those of the usual theory. It seems possible, however, that in effects occurring in atoms or rays of light the times involved may be small enough to be comparable with T; in these cases the classical theory will no longer hold, and an entirely different treatment is required. The paper discusses some of the effects which may be expected under these conditions; these include the spontaneous dissociation of electronic systems and the production of Röntgen-rays. It follows, too, from the theory that there would be no radiation of energy from an electron describing a circular orbit. The theory also has an important application to the propagation of light; it shows that light cannot be propagated as divergent waves where the electric force falls off as the waves recede from the source; it requires that light should be corpuscular in character, *i.e.* must consist of units whose energy does not change as they travel through space.

H. H. Ho.

1621. *On the Adjustment of J. J. Thomson's Theory of Light to the Classical Electromagnetic Theory.* **E. T. Whittaker.** (Roy. Soc. Edinburgh, Proc. 46. 1. pp. 116–125, 1925–1926.)—In many recent publications [see Abstract 177 (1925)] J. J. Thomson has suggested a corpuscular theory of light, in a sense similar to that advocated by Einstein and others, *viz.* the energy of light being made up of parcels or quanta which retain their energy undiminished as they travel out into space without the unlimited spreading which takes place with ordinary diverging waves, but with the distinction that the structure of the light-quanta is pictured in terms of tubes of electric force. The object of the present paper is to bring the above theory within the compass of an extended form of the Maxwell-Lorentz theory of the electromagnetic field. The author first provides a justification of Thomson's hypothesis, and shows alternatively that the lines of electric force in a light-quantum must be closed curves in planes perpendicular to the direction of propagation. An analytical construction of the field is then given in which the inclusion is made of the volume-density of the magnetism whose convection constitutes the magnetic current involved necessarily in Thomson's assumption of closed lines of electric force. By this means the Maxwell-Lorentz equations are made capable of representing Thomson's ideas regarding light. A solution is also offered to the problem that in photoelectric phenomena the atoms affected seem to have a "catchment area" for the incident light far exceeding the actual dimensions of the atoms; for the above type of light-quantum has, by virtue of the magnetism, a kind of coherence, so that if an atom gets in touch with a quantum at one point it may be able to grip and suck in the whole quantum. Propagation in a dielectric is finally discussed and the quantum relation derived whereby the correct law of refraction of light from a theory of light-quanta may be obtained. Remarks on electric vortex-rings conclude the paper.

H. H. Ho.

1622. *Various Geometries giving a Unified Electric and Gravitational Theory.* **J. M. Thomas.** (Nat. Acad. Sci., Proc. 12. pp. 187–191, March, 1926.)—It is shown that the equations of Einstein's unified theory of electric and gravitational fields can be obtained by direct generalisation of the equations of the gravitational field previously given by Einstein. The process of generalisation consists in abandoning assumptions of symmetry and in adopting a novel definition of covariant differentiation which reduces to the usual definition when the connection is symmetric. The adoption of the ordinary definition of covariant differentiation leads to a geometry which includes, as a special case, that proposed by Weyl as a basis for electrical theory; moreover, the asymmetric connection for this special case is of the type adopted by Schouten for the geometry underlying his electrical theory.

J. S. G. T.

1623. *Plane Spark Tracts with Correct Edge Development.* **W. Rogowski and H. Rengler.** (Archiv f. Elektrot. 16. pp. 73–75, April 6, 1926.)—This is a continuation of the work of the author on the electric field at the edges of plate condensers [see Abstract 1194 (1923)]. The question is dealt with mathematically, starting from the Schumann simplification of the Townsend discharge condition $\int \alpha ds = K$, where α is the ionisation constant of negative ions, ds a line element of a line of force, K a constant. The integration is to extend over the whole course of a line of force. A. E. G.

1624. *The Rupture Field Strength of Air for Plane Electrodes with Correct and False Edge Development.* **H. Rengler.** (Archiv f. Elektrot. 16. pp. 76–96, April 6, 1926.)—Diagrams showing the experimental arrangements for direct and alternating currents are given, as are also photographs of the electrodes. Among the experimental results given in tabular form are the following: Comparison of the measured field strength for alternating and direct tension with 120° electrode; the influence of thickness of the plates; a comparison of the influence of thickness and surface of the plates; the rupture field strength, with direct and alternating current; a comparison of the measured with the calculated field strength. There is a lengthy mathematical discussion of the question, and the results are also dealt with by means of graphs. A. E. G.

1625. *Principles of a Theory of the Terrestrial Electric Field.* **H. Benndorf.** (Akad. Wiss. Wien, Ber. 134. 2a. No. 5–6. pp. 281–315, 1925.)—In two sections. In the first, excluding perturbations of the normal field, investigation is confined to the case in which its local and temporary alterations are conditioned solely by the two factors, incoming current and electric conductivity of the air. In the second section an attempt is made by means of a simplified model of the atmosphere to picture the processes of atmospheric electric phenomena. It is assumed that conductivity near the earth is everywhere equal, and that there is no transport of electricity by convection, but only by atmospheric conduction and incoming current. [See Abstract 1168 (1925).] Entirely mathematical. E. F.

DISCHARGE AND OSCILLATIONS.

1626. *Effect of Metal Ring on Glow Discharge.* **S. Procopiu.** (Phys. Zeits. 27. pp. 57–58, Jan. 15, 1926.)—A movable ring of wire surrounds a cylindrical gas discharge-tube. When placed in metallic contact with the anode it has the effect of increasing the discharge current passing; when joined to the kathode it interrupts, diminishes or increases the current according to its position along the tube. An explanation on the electronic theory is given. G. A. S.

1627. *Changes in the Refractive Index of Helium produced by a Glow Discharge.* **W. H. McCurdy** and **A. Bramley.** (Phys. Rev. 27. pp. 314–317, March, 1926.)—Interferometer method of measuring the concentration of ions and excited atoms in a glow discharge.—According to the Lorentz theory the presence of atoms in a state s should change the index of refraction of the discharge for light of wave-length ($\lambda = \lambda_s + \delta\lambda_s$) by an amount $\delta n = (N_s e^2/8\pi^2 c^2 m)(\lambda^3_s/\delta\lambda_s)$, where N_s is the concentration of excited atoms. Kramer's theory leads to a somewhat different relation. To measure δn, a Michelson interferometer was used, into one arm of which was introduced a cylindrical discharge-tube with a filament kathode in a side arm, and a ring anode, so that the light passed along the positive column.

In the tests made with He, an iron arc was used as source, and the light from the half-silvered mirror was focussed on the slit of a spectrograph. When the glow discharge was started (30 to 40 milliamps.), shifts to 0·2 to 0·5 fringe were observed for about 15 Fe lines. In each case the shift was positive or negative according as the wave-length was greater or less than that of a neighbouring He line. The results are not quantitative as yet, but prove the practicability of the method. AUTHORS.

1628. *Stability of Gas Discharge.* **W. Dällenbach.** (Phys. Zeits. 27. pp. 101–107, March 1, 1926.)—This is a mathematical paper which claims that the calculations given takes into consideration conditions not included in those dealt with by Kaufmann. [See Abstract 1672 (1900).] A. E. G.

1629. *The General Conditions of Discharge in Gases and Mixtures of Gases.* **W. O. Schumann.** (Archiv f. Elektrot. 16. pp. 46–57, April 6, 1926.)—In a previous article the author has dealt with the intensity of field at discharge, when the field is homogeneous, and in the present paper he extends his investigation to non-homogeneous field distribution. In the mathematical treatment it is assumed that a certain fraction ϵ of the electrons unite with molecules to form negative molecular ions, and that a fraction κ of these break up and give off their electrons. The conclusion is drawn that where such negative ions are formed polarity effects are to be expected, while when no such effects are observed the formation of negative ions (*Anlagerung*) is of no essential importance. Several different cases are considered, and equations are obtained for gas mixtures which, however, except for very small voltages, when no positive ionisation is produced, are very complicated. H. N. A.

1630. *Intermittent Glow Discharge in Neon.* **F. M. Penning.** (Phys. Zeits. 27. pp. 187–196, April 1, 1926.)—In neon at least four different types of discharge are found. The present paper deals with the intermittent discharge similar to that in air described by Geffcken [Abstract 1703 (1925)]. It is shown that Geffcken's formula is not in agreement with observations for neon. Measurements of the maximum and minimum potentials in the tube during one period showed that the introduction of these variable values in the formula gave much better agreement, the remaining discrepancies being attributed to the decay of the discharge. The discharge was also studied by means of a rotating mirror and a stroboscope. The passage from the continuous to the intermittent discharge was investigated, and from the results obtained it appears that Kaufmann's formula does not agree with observation. A. W.

1631. *Radiation from Electric Discharges.* **J. J. Thomson.** (Engineering, 121. p. 374, March 19, 1926. Electrician, 96. p. 465, April 23, 1926. Lecture delivered before the Royal Inst., March, 1926.)—In the course of the lecture the lecturer showed, by a particularly interesting experiment, that it was possible to obtain currents in a gas without producing luminosity. For this purpose he employed two concentric spherical bulbs, the inner one containing gas at a constant pressure, such that an electric discharge would readily traverse it. The outer bulb was connected to a vacuum pump, so that the pressure could be reduced as required, and was surrounded by a coil of wire carrying the current from an induction coil. When a current was first passed through the coil, the

gas in the inner bulb glowed brightly, but as the pressure in the outer bulb was reduced, so that the contained gas became a conductor, the glow ceased, due, the lecturer explained, to the shielding of the gas in the outer bulb, which was then carrying a current without emitting light.
G. W. DE T.

1632. *The Potential Gradient in the Vicinity of a Thin Wire.* **H. Busch.** (Zeits. f. Physik, 36. 3. pp. 188–192, 1926.)—This investigation has been undertaken to correct the erroneous view that in a cylinder condenser, whose inner conductor consists of a very thin wire, almost the entire potential decline takes place in the immediate neighbourhood of the wire. The paper is a criticism of a previous paper by Güntherschulze [see Abstract 587 (1926)] and an explanation of the Katsch observations [see Abstract 2140 (1925)].
H. H. Ho.

1633. *A Reply to the Paper by Busch: The Potential Gradient in the Vicinity of a Thin Wire.* **A. Güntherschulze.** (Zeits. f. Physik, 36. 3. p. 193, 1926.)—The author commences his reply by admitting the validity of Busch's standpoint, and then states that his previous work on electronic orbits has for objective the derivation of a simple formula which would permit a judgment of the phenomena discovered by Katsch [see Abstract 2140 (1925)]. He points out that his formula, obtained by certain simplifications, is not a rough approximation as stated by Busch, but that while strictly valid only for an infinitely thin kathode wire, its deviations for finite wires increase with their thickness as compared with the dimensions of the apparatus.
H. H. Ho.

1634. *Cooling Effect at Oxide Kathodes.* **W. Schottky.** (Zeits. f. Physik, 36. 4. pp. 311–314, 1926.)—This paper is a comment on the work of G. Michel and H. J. Spanner [see Abstract 1087 (1926)]. The reason why the electron heat of cooling of a pure substance by the laying on of foreign layers must vary in a first approximation as the electron work of emergence is discussed. A compensating heat effect appears at the anode.
A. E. G.

1635. *Determination of Filament Temperature in Electron Tubes.* **H. G. Möller and F. Detels.** (Zeits. f. Hochfrequenztechn. 27. 3. pp. 74–81, 1926.)—After briefly indicating the objections to the usual methods of measuring filament temperatures a new method is described. This is based on Maxwell's formula for the velocity distribution of the electrons emitted by the incandescent wire. Anode and grid are connected together, an opposing potential ϕ is applied, and the electron current I is measured. Theory gives the simple approximate formula for the temperature $T = -(\epsilon/\kappa)d\phi/d(\log I)$, where ϵ is the electron charge and κ the molecular gas-constant. The possible sources of error of this method are fully considered, and conditions are given for accurate results. Measurements with tungsten wires are more easily made than with oxide-coated filaments, but numerical results given show that even with the latter the method is capable of great accuracy.
A. W.

1636. *Analogue of Clapeyron's Law in the Case of Evaporating Electrons.* **J. Droste.** (K. Akad. Amsterdam, Proc. 28. 10. pp. 900–904, 1925.)—O. W. Richardson's equation relating to the equilibrium of a hot metal with the electrons it emits, which is easily verifiable in those cases in which the electric potential can be calculated, is here shown to hold good in the case of an arbitrarily shaped evacuated enclosure bounded by bodies of the same metal. G. A. S.

1637. *On the Critical Voltages of Emanation.* **F. Struwe.** (Ann. d. Physik, 36. 6. pp. 410–413, 1926.)—In this paper it is shown from the latest measurements by Hertz and Kloppers [see Abstract 1712 (1925) for the ionisation voltages of Ar, Kr and Xe that Turner's value for Em of 27·5 volts is much too high, and that even one of 4·66 volts is not very probable. There arises a linear dependence for the critical voltages of Ar, Kr and Xe, and the periodic number as well as for the order number which enables an extrapolation of the following data for Em: Excitation voltages, 6·7–5·5 and 8·4–7·2; ionisation voltage, 9·5–8·0. All these values are based on the Moseley law for the P_{III}-levels. H. H. Ho.

1638. *The Emission of Electrons under the Influence of Intense Electric Fields.* **Research Staff of the General Electric Co., London.** (Phil. Mag. 1. pp. 609–635, March, 1926.)—Discharge currents of considerable strength were obtained by Lilienfeld [see Abstract 914 (1923)] in high vacuum X-ray tubes, using as the kathode a metal electrode provided with sharp points or edges. It was inferred that the discharge took the form of a number of very fine pencils of kathode-rays. The present paper contains an account of work in this field, and commences with a general description of the phenomena and in particular of the conditions under which definite numerical data can be obtained. The latter are then collected under the following heads: (*a*) The rapid continuous radiation of the current (10^{-9} to 10^{-2} amps.) with the applied voltage, and the connection of these variables by a simple empirical relation; (*b*) the nature of the discontinuous irregularities of the discharge; (*c*) the influence of sodium and similar substances on these irregularities; (*d*) the small and generally negligible effect of the temperature of the kathode (300° K. to 1700° K.); (*e*) minimum estimates of the current density (10^6 amps./cm.^{2}) and of the surface field (5×10^5 to 5×10^2 volts/cm.); (*f*) the gradient of the current/voltage relation. Schottky's theory of the antelectronic discharge is then briefly examined in the light of the measurements, and the general conclusion is reached that while the numerical data are not necessarily inconsistent with the fundamental assumption of the theory, the question of the actual mechanism of emission is best left open, particularly since the data are definitely inconsistent with any simple application of the theory of thermionics.

H. H. Ho.

1639. *Electronic Phenomena at the Surface of Metals.* **C. E. Mendenhall.** (Frank. Inst., J. 201. pp. 269–278, March, 1926.)—Attempts to obtain stable limiting surface conditions in a metal lead to the conclusion that there are two changes produced by thermal ageing of a surface in a high vacuum: one the outgassing, which in itself is quite complex, and the other the development of a surface structure; and that outgassing in general reduces the number of secondary electrons, while crystallisation tends to increase the number and to develop characteristic features in the secondary electron curve. With this point of view, fairly well established in connection with the phenomena of electronic bombardment, it is obvious that the same two changes are occurring in the heat treatment of surfaces being prepared for photoelectric or contact e.m.f. measurements, and it may be that while it has not been possible so far to separate these two effects—outgassing and change of structure—it is their undetermined combination which is responsible for the variable results which have been obtained and for the difficulty of securing reproducible and stable limiting surface conditions. G. A. S.

1640. *Limitations of the Theoretical Equations for the Mobilities of Gaseous Ions.* **L. B. Loeb.** (Frank. Inst., J. 201. pp. 279–299, March, 1926.)—It is here shown that the remarkable degree of independence of the mobility and inertia of the ion leads to the conclusion that the ageing effects found by Erikson are due to changes in diameter of the ion. The changes in diameter, however, must be small. Further evidence for clustering in ions in mixtures of gases comes from the recent work of the writer. An attempt is made to explain the differences in positive and negative ion mobilities by a study of the structure of the molecule in a qualitative fashion. This leads to the conclusion that further quantitative progress in an understanding of ionic behaviour requires that the law of force between molecules and ions at close approach be known. A review of ionic mobility theories shows that the only ones which are capable of explaining the results in the light of this evidence are those which consider elastic impacts between ions and molecules which exert forces on each other. The best of these is the one due to Langevin. It, however, is defective in the same sense that all theories at present must be defective in that it has not the true law of force between ions and molecules at close approach. [See also Abstracts 1094 and 1095 (1926).] A. E. G.

1641. *Critical Ionisation Potentials by Positive-ion Impact.* **W. J. Hooper.** (Frank. Inst., J. 201. pp. 311–331, March, 1926.)—Previous work in this field has been repeated with apparatus designed to distinguish between ionisation and spurious factors, a great many current-potential measurements and curves being obtained at different gas-pressures and with a variety of electrical arrangements. The data and curves thus obtained present direct evidence (*a*) that the previously so-called "ionisation-current" is due to a secondary electron emission from the platinum walls of the ionisation chamber; (*b*) that this secondary electron emission is produced by the impact of the positive ions with these metal walls; (*c*) that either there is no ionisation in hydrogen gas by the impact of the positive ions accelerated by potential differences up to 925 volts, or that if this phenomenon exists, as is indicated by visual and spectroscopic evidence, its effects are so small at relatively low pressures (0·012 mm.) that it is completely masked by secondary phenomena which make its detection by the ordinary direct methods problematic; and (*d*) that it seems possible that at relatively high gas-pressures (considerably above 0·012 mm.) ionisation by positive ions might be an important factor with accelerating potential differences between the ends of their m.f.p. well within this same range of voltages. H. H. Ho.

1642. *Ionic Mobility in Gases.* **M. Laporte.** (Comptes Rendus, 182. pp. 620–622, March 8, 1926.)—Describes an apparatus by which a method similar to the tooth-wheel method used by Fizeau to measure the speed of light can be applied to determine the relative proportions of ions of different mobilities in gases. Experiments have been carried out on moist and dry air, oxygen and nitrogen, on carbon dioxide at different pressures, and on argon, but results are given only for air. A diagram of the apparatus is included. W. H. GE.

1643. *Ionic Mobility in Gases.* **M. Laporte.** (Comptes Rendus, 182. pp. 781–784, March 22, 1926.)—Continuing the work of a previous paper (see preceding Abstract), results are here given for the measurements made upon positive ions in dry air. W. H. GE.

1644. *Fundamental Considerations on the Thermionic Effect.* **N. v. Raschevsky.** (Zeits. f. Physik, 35. 11-12. pp. 905–919, 1926.)—The author discusses a recent paper by W. Schottky [Abstract 832 (1926)], and investigates the hypotheses on which the various thermodynamic deductions from the electron emission formula are based, showing how these different methods are related to one general "ideal" method. The question of the number of the independent variables is discussed, and former deductions concerning the dependence of the thermionic effect on pressure are confirmed. The dependence of the constants of the emission formula on the chemical constant of the emitting substance is investigated and the question raised of the possibility of different laws underlying the behaviour of different substances [see Abstracts 2343, 2579 (1925)]. Mainly mathematical. E. F.

1645. *A Study of the Concurrent Variations in the Thermionic and Photoelectric Emission from Platinum and Tungsten with the State of the Surfaces of these Metals.* **T. H. Harrison.** (Phys. Soc., Proc. 38. pp. 214–232; Disc., 232–233, April, 1926.)—An attempt has been made to measure the thermionic and photoelectric work functions for the same specimens of tungsten and platinum. It is found that in all cases the results depend greatly on the previous heat treatment of the material. In the case of platinum the curves showing the dependence of photoelectric sensibility on the wave-length of the irradiation are of four different types, while as regards thermionic properties, the specimens can take up either a "large-emission" or a "small-emission" state, according to their treatment. The photoelectric work function of platinum appears to be greater than the thermionic, but no definite results were obtained for tungsten. The photoelectric curves obtained for both metals did not end abruptly so as to indicate a maximum wave-length for emission, but extended asymptotically towards zero emission in the direction of increasing wave-length. These irregularities in behaviour are attributed by the author to the state of the surface of the specimens. AUTHOR.

1646. *Optical Phenomena observed in a Tube by Positive Emission from Lithium.* **M. Morand.** (Comptes Rendus, 182. pp. 883–885, April 7, 1926.)—Further properties observed with an apparatus described earlier [Abstract 1442 (1926)] are detailed. Positive rays in the most deviated part of the beam are absolutely invisible, but produce fluorescence on the walls of the tube. No radiation characteristic of the metal was observed at these points. The positive rays only become luminous by bombardment or accidental neutralisation. The feeble uniform ionisation of non-deviated particles is probably due to collision with neutral particles which have acquired a speed greater than for those near the anode. When the anode is recoated with the Li salt, positive hydrogen ray emission is seen, but none corresponding to H_2 or H_3, these ions coming directly from the anode. They are emitted more readily than the Li ions and with a feebler electric field. R. S. R.

1647. *Propagation of Electromagnetic Waves.* **G. J. Elias.** (Zeits. f. Hochfrequenztechn. 27. 3. pp. 66–73, 1926.)—A discussion is given relative to the ionisation conditions of the upper atmosphere (Heaviside layer). The α-rays emitted from the sun may give rise to a permanent ionisation, while by day the sun's radiation is also effective. With these conditions and making certain simplifying assumptions the number of ions is calculated. A height is found for the permanently ionised layer of about 80 km. and for that of the daily layer of about 50 to 60 km., the first being much more sharply defined than the second. Further, the electric constants of the upper atmosphere are calculated. The results obtained are used to explain the behaviour of different wave-lengths by day and by night. The theory explains satisfactorily many of the essential facts. A. W.

1648. *Electric Waves in the Region of the Outer Ultra-red.* **Marie Lewitsky.** (Phys. Zeits. 27. pp. 177–182, March 15, 1926.)—The method adopted in these experiments is similar to that described in a previous paper [see Abstract 1556 (1924)]. Two different oscillator systems are used. In one system the wave-lengths 30, 136, 330, 375, 450 and 508 always appear in the other wave-lengths 136, 185, 270, 310 and 470. It is not excluded that the spark space also emits some long-wave heat rays, and it is not decided here which wave-lengths actually belong to the oscillators. Measurements with the plain grating show that the refraction index of rock-salt in the region 100–400 μ only varies little, and its magnitude must lie very near the optical refraction index. The energy of the electric oscillations of the described oscillators is extraordinarily small. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1649. *Electrical Conductivity of Solid Salt Mixtures.* **P. Fischer.** (Zeits. Elektrochem. 32. pp. 136–143, March, 1926.)—The conductivity of solid mixtures of salts was determined. The salt mixtures were compressed into cylinders, which were clamped in a specially designed holder and placed in an electric furnace, so that the temperature could be kept constant during the measurements, and when desired the temperature could be raised so that the salt mixture could be fused, and the conductivity again determined. The conductivity was determined for both direct and alternating current for the following mixtures: silver iodide-silver bromide, silver iodide-potassium iodide, silver bromide-potassium iodide, silver bromide-lead bromide, cuprous chloride-lead chloride, copper sulphide-sulphur. The temperature was below the melting-points of the mixtures. The results showed that copper sulphide-sulphur conducts as a metallic conductor; the remaining mixtures conduct electrolytically. The mixtures of solid salts do not follow Ohm's law. The conductivity for direct current differed considerably from that for alternating current. The conductivity of the pressed powders is different from that of the same mixture when fused together. The conductivity did not allow of deductions as to quantities of the ingredients to be made. It was found that occasionally a small change in quantities made a large change in the conductivity, while in other instances a large difference in composition made practically no change. F. J. B.

1650. *Supraconductive Metals in the Form of Thin Films.* **G. J. Sizoo and H. K. Onnes.** (K. Akad. Amsterdam, Proc. 28. 10. pp. 971–976, 1925.)—The resistances of thin films of thicknesses of from 0·3 to 0·5 μ obtained by kathode sputtering are measured under varying low temperature conditions, and their behaviour is found to be different from that of tin wires. Quantitative results are difficult to interpret, as the resistance of such a film varies with time. G. A. S.

1651. *Association, Adsorption and Dielectric Constant.* **C. T. Zahn.** (Phys. Rev. 27. pp. 329–340, March, 1926.)—Dielectric constant of water-vapour at pressures 3 to 20 mm. and at temperatures 23 to 165° C.—Using a heterodyne beat method previously described [Abstract 608 (1925)], a study has been made of the variation of the dielectric constant with pressure and temperature. At room-temperature, the curve connecting $(\epsilon - 1)$ with pressure consists of two straight parts connected by a transition curve. This change of slope is less marked at higher temperatures and disappears at about 47° C. The rectilinear portion below the transition pressure corresponds to the normal behaviour of water-vapour. The abnormal behaviour above the transition pressure cannot be explained satisfactorily by the association theory suggested by Jona in connection with his results. It is suggested, rather, that the anomaly is due to the formation of an adsorbed layer of water on the condenser plates. As the number of adsorbed molecules increases, the vapour-pressure increases, approaching the ordinary vapour-pressure as a limit. The final thickness of the layer at saturation pressure is of the order of the radius of molecular attraction and comes out of the order of several microns, corresponding to about 200 molecular layers. The experimental results are in general agreement with this theory. AUTHOR.

1652. *Dielectric Constants of Hydrogen.* **W. Werner and W. H. Keesom.** (K. Akad. Amsterdam, Proc. 29. 1. pp. 34–43, 1926. Comm. No. 178a from the Phys. Lab., Leiden.)—A study of the variations of the dielectric constant of liquid and of solid hydrogen with temperature. The dielectric constant of liquid hydrogen at the boiling-point (20°·36 K.) is 1·2311 ± 0·00024; from the boiling-point down to near the melting-point the dielectric constant rises linearly to 1·2533. For solid hydrogen near the melting-point the dielectric constant is 1·206 to 1·209, and falls on further cooling. A. D.

1653. *Dielectric Constants of Natural and Artificial Mixtures.* **K. Lichtenecker.** (Phys. Zeits. 27. pp. 115–158, March, 1926.)—A critical summary and exposition of existing data under the following main heads: (1) Historical survey and general significance of the problem. (2) Comparison of various formulæ proposed for mixtures. (3) Refractive indices of mixtures. (4) and (5) Dependence of refractive index and dielectric constant upon density. (6) Dielectric constants of liquids under high pressure. (7) Dependence on temperature. (8) Anisotropic mixtures. G. A. S.

1654. *Dielectric Constants of Electrolytes.* **H. Sack.** (Phys. Zeits. 27. pp. 206–208, April 1, 1926.)—In the calculation of molecular radii from measurements of dielectric constants in dilute solutions of electrolytes the high values which are obtained for the apparent radius, amounting to from 11 to 15·7 Å.U. in the case of potassium chloride, are attributed to the part played by the charges on the ions in orienting the water bipoles and thus preventing them from responding to an external electric field. Relations are derived to enable the calculation of the "saturation sphere" or radius of influence of the ions. A formula is deduced which gives the dielectric polarisation in terms of the concentration of bipoles, their moment, the strength of internal and external electric fields, and the optical polarity. The dielectric constant is related to the "saturation sphere" of the ions by the formula $D = e/Xr^2$, where X is the external field, e the ionic charge, and r its apparent radius. By taking the optical value of the dielectric constant of water as 3, the dielectric constant of a mono-monovalent salt solution is expressed by the formula $D = 80(1 - 3{\cdot}0\gamma)$, where γ is the concentration in grm. mol. per litre. In accordance with the derived expressions, this corresponds to a saturation sphere of 8·6 Å.U. radius and is independent of the actual dimensions of the ion. J. N. P.

1655. *Electrostatic Virial of Strong Electrolytes.* **E. Q. Adams.** (Am. Chem. Soc., J. 48. pp. 621–626, March, 1926.)—Since the customary methods of measuring the dielectric constant of water involve measurements of the electric work obtainable by discharging at constant pressure a condenser filled with water, it is argued that a virial term for the energy of strong electrolytes in aqueous solution (derived from K, the dielectric constant of water) should be denoted by ΔF (free energy at constant pressure), not by ΔU (total internal energy). Only if the dielectric constant is independent of the temperature are these two thermodynamic functions equal. In general, the expressions for ΔU and for ΔH must be multiplied by the factor $1 + d\,ln\,K/d\,ln\,T$, the value of this being $-0{\cdot}5$ for water between 10° and 100°. Evidence is advanced which indicates that Milner's method of calculating the virial [Abstract 1070 (1912)] gives neither ΔU nor ΔF, but ΔA (work content = Helmholtz's free energy); for an inverse square force, $\Delta A = \frac{2}{3}\Delta F$. T. H. P.

1656. *Recent Work on Dielectric Constants.* **O. Blüh.** (Phys. Zeits. 27. pp. 226–267, April 15, 1926.)—A full *résumé*, with bibliography, of recent work. It comprises: Introduction.—Theory: dielectric constant and temperature; the dipole theory of anomalous dispersion; dipole moments; dielectric constants and the quantum theory. New Methods of determining the Dielectric Constant: the improved Nernst method; production of undamped oscillations, wave-length order of 1 metre; resonance methods; Fürth's ellipsoid method; suspension methods; different other methods. Data of Observation.—I. Gases: dependence on temperature; dependence on pressure; constant for liquefied gases; constant for vapours. II. Liquids and Solutions: dependence on temperature; dependence on pressure; constants of various substances; absorption and dispersion; mixtures of liquids; chemical constitution; the constant of water; the constants of aqueous solutions; the constants of non-aqueous solutions; theory of the constants of solutions; colloid solutions and fluid crystals; the constant in biology. III. Solids; various substances; phosphorus; dielectric after-effects. A. D.

1657. *Photoelectric Cell.* **S. Schlivitch.** (Comptes Rendus, 182. pp. 891–893, April 7, 1926.)—With the aid of a Lippmann capillary electrometer sensitive to 1/10,000-volt measurements were made of the e.m.f. between two similar platinum electrodes, one of which was illuminated by the visible portion of the rays from a quartz mercury-vapour lamp. Various concentrations of three solutions were used [$K_2Cr_2O_7$, $(NH_4)_2Cr_2O_7$ and $NaNO_2$], and the results are set out in a table from which the growth and decay with time of the e.m.f. can be seen. W. H. Ge.

1658. *Quantitative Theory of an Electrostatic Voltage Multiplier.* **A. W. Simon.** (Phys. Rev. 27. pp. 341–345, March, 1926.)—The detailed quantitative theory of a symmetrical, four-carrier, electrostatic voltage multiplier is developed. It is shown that a machine of this type steps up a given applied d.c. potential in a definite ratio, and a formula for this (transformation) ratio is deduced in terms of the coefficients of capacity and the coefficients of induction of the elements of the machine in a definite configuration. A formula which gives the potential of the receivers for every geometrical cycle (quarter turn) is deduced. While the current furnished by a device of this sort is extremely small, it may be used separately to excite an ordinary static machine, so that this machine will give a constant current at a constant high potential. [See also Abstract 2561 (1925).] Author.

1659. *A Reliable Thermo-Converter.* **W. J. H. Moll.** (Journ. Sci. Instruments. 3. pp. 209–210, April, 1926.)—The usual instruments for alternating-current measurements have but a low precision as compared with direct-current instruments. In the paper a description is given of an apparatus which transforms the alternating current into a direct one by means of the thermo-electric effect. In combination with a good millivoltmeter it forms an instrument of high precision for alternating-current measurements. Author.

ALTERNATING CURRENTS AND MAGNETISM.

1660. *Energy Transfer in Inductively Coupled Circuits.* **J. Kammerloher.** (Zeits. f. Hochfrequenztechn. 27. 3. pp. 81–86, 1926.)—A theoretical investigation shows that for two oscillatory circuits tuned to the same frequency and inductively coupled together the energy transfer from one circuit to the other is a maximum when the coefficient of mutual induction is given by the formula $M = \sqrt{R_1 R_2}/\omega$, where R_1 and R_2 are the effective resistances of the two circuits. A similar relation is obtained for the coupling coefficient χ for maximum energy in the second circuit. In this case $\chi = \sqrt{\delta_1 \delta_2}/\pi$, where δ_1 and δ_2 are respectively the damping decrements of the two circuits. Experimental tests gave results agreeing with the above formulæ to within about 5 %. A. W.

1661. *Circuits containing Imperfect Condensers.* **W. O. Schumann.** (Elek. u. Maschinenbau, 44. pp. 221–232, March 21, 1926.)—A study of circuits containing imperfect condensers, with special application to gas purification plants. An imperfect condenser may be replaced by a perfect condenser (*i.e.* one exhibiting no loss) shunted by a non-inductive resistance. Modern gas purification plants are almost invariably worked with a uni-directional voltage obtained from the secondary of a transformer by means of a mechanical rectifier, and it is of the utmost importance that the current should be at its zero value when reversal occurs. The current may be brought into phase with the voltage by connecting in series with the leaky condenser a parallel circuit one of whose branches consists of a self-inductance L and the other of a non-inductive resistance r equal to the equivalent shunting resistance of the leaky condenser, and by choosing L so that $r = \sqrt{L/C}$, where C is the capacity of the condenser. The theory of such a circuit when subjected to a rectified sinusoidal voltage is fully worked out by the author. Certain other arrangements of circuits are considered which also possess the property of being equivalent to a non-inductive circuit at all frequencies. A. H.

1662. *Complex Magnetisation.* **E. Peterson.** (Phys. Rev. 27. pp. 318–328, March, 1926.)—Magnetisation of silicon steel by two sinusoidal fields of differing frequencies.—The energy loss per cycle W and the flux density B associated with each of the two frequencies were determined when the two sinusoidal magnetising forces were simultaneously impressed on a toroidal silicon steel core built up of one-mil laminations. A null method was used which permitted suppression of the modulated currents and constancy of the impressed currents during manipulation for balance. The frequencies used were 400, 821 and 1582. Six sets of measurements were taken with fixed magnetising forces ranging from 0·5 to 10 gilberts/cm. and superposed forces up to 15 gilberts/cm. The results show that the effect of superposition depends upon the relative amplitudes and upon the frequency ratio R of the superposed frequency to the other. At low fixed fields W and B go through maxima as the superposed field is increased, the maximum value increasing with R. The maximum is less pronounced or absent for the higher fixed fields. In general B is smaller with a low than with a high value of R, other things being equal. The effect on W is not as sharply defined; in general the effect of superposition is more pronounced the higher the superposed frequency. The amplitude effect and frequency ratio effect are shown to be in general agreement with conclusions drawn from mathematical treatment of somewhat simplified cases, and it is concluded that the effects are not inconsistent with purely hysteretic phenomena. AUTHOR.

1663. *Observation and Measurement of Minute Isolated Magnets.* **F. Ehrenhaft.** (Comptes Rendus, 182. pp. 1138–1141, May 10, 1926.)—An experimental arrangement is described, whereby a small charged magnetic particle is subjected to controllable electric and magnetic forces besides, of course, the gravitational attraction. The particle is observed through a microscope, and its velocity determined. The velocities found with the magnetic and electric forces applied separately and then simultaneously and finally with only the gravitational force acting, enable the charge, density, radius and magnetic susceptibility of the particle to be calculated. Magnetic particles for which the product of volume and magnetic susceptibility equals 10^{-18} can easily be measured by this method. W. S. S.

1664. *Permeability and Hysteresis at High Frequencies, and the Fundamental Equations for Ferromagnetics.* **W. Jaeger** and **W. Meissner.** (Zeits. f. Physik, 36. 2. pp. 161–168, 1926. From the Reichsanstalt.)—The effect of frequency on permeability has been determined by way of resistance measurements, the resistance itself being found by indirect methods [see Abstracts 633 (1919), 1472 (1921) and 1285 (1924)]. The authors suggest the employment of a modified Wheatstone bridge method for the purpose. An energy equation is formed from expressions for the electromagnetic energy in unit volume, the rate of flow of energy from the element as obtained from Poynting's theorem, and the heat produced electrically and by hysteresis. This leads to two incompatible equations and a magnetometric method is suggested by means of which one of these equations may be tested. G. E. A.

1665. *The Magnetic Susceptibility of Aqueous Solutions of Salts of the Rare Earths.* **H. Decker.** (Ann. d. Physik, 79. 4. pp. 324–360, March 13, 1926.)—A discussion of the various methods available for the measurement of susceptibility of liquids, together with a more detailed account of Bequerel's method, using a rod of material immersed in the liquid upon which the experiment is being performed. The method employed by the author is a null method, the relative susceptibility of the liquid being obtained from the angle of twist to restore the rod to its original position before the field was established. Experimental detail is given. The results of a large number of measurements show good agreement with previous results by Cabrera and S. Meyer, and demonstrate the variation in susceptibility with increasing atomic number of the rare earths. W. V. M.

1666. *Alloys with Special Magnetic Properties.* **H. Freese.** (Zeits. f. Hochfrequentztechn. 27. 3. pp. 86–97, 1926.)—This paper presents in a concise form the magnetic and physical properties (particularly the former) of various alloys. These include the Heusler alloys, alloys of iron with carbon, silicon and aluminium, tungsten and chrome steels, manganese steel, the iron-cobalt series, the iron-nickel series, cobalt-nickel and iron-cobalt-nickel. A number of useful diagrams are given, and the paper concludes with a comprehensive reference list. A. W.

1667. *Fundamental Laws of Magnetic and Dielectric Polarisation on the Quantum Theory.* **P. Debye.** (Phys. Zeits. 27. pp. 67–74, Feb., 1926.)—The author gives a statistical and thermodynamic deduction of the law relating the polarisation of a molecular medium to the intensity of the inducing field, applicable to both magnetic and dielectric polarisation. Initially the intermolecular forces are omitted, and the molecules are assumed to exist in a series of discrete states, the energy of a particular state being expanded in powers of the field intensity. In the absence of the field the energies of the different states reduce to a common constant. It is shown that, provided the induced moment is proportional to the field intensity, the mass susceptibility (magnetic or dielectric) is given by the formula $\chi = A + \frac{B}{T}$, where T is the absolute temperature and A and B are constants. In the magnetic case, on omitting A, which measures the diamagnetic magnetisation and is in general very small compared with B/T, Curie's law results. The expressions obtained for

A and B involve the coefficients of the energy expansions of the discrete states. The values of these are to be obtained, on the basis of Bohr's theory, from the optical data supplied by the Zeeman- and Stark-effects. The coefficients of the terms linear in the field correspond to the linear Zeeman- and Stark-effects. The coefficients of the second degree terms control the corresponding quadratic effect. When the interaction of the molecules is taken into account, a set of discrete energy states must be assumed even when the external field is zero. The necessary modification of the formula for χ is derived and shown to agree to a first approximation with Weiss's law, $\chi = \frac{C}{T - \Theta}$, although the physical interpretation of the constants is different and certain anomalies are avoided. W. S. S.

1668. *Different Magnetic States of Cobalt Chloride.* **A. Chatillon.** (Comptes Rendus, 182, pp. 765–767, March 22, 1926.)—This substance is found to possess from 23 to 26 magnetons, according to its physical state. It has 23 when in alcoholic solution; the solid at temperatures between 110° and 208·5° C. has 24; at temperatures between − 80° and 50° C. the solid has 25, and also in the calcined state; and it has 26 magnetons when in aqueous solution or when the solid form is obtained from an ethylic solution. [See also Abstract 864 (1926).] G. E. A.

1669. *Thermomagnetic Properties of Ferrites.* **H. Forestier** and **G. Chaudron.** (Comptes Rendus, 182, pp. 777–779, March 22, 1926.)—Deals with the influence of change of temperature upon the magnetisation of seven ferrites Fe_2O_3MO, where M is nickel, copper, lead, barium, calcium, cadmium or zinc. The apparatus is similar to that used by Curie, with the addition of photographic recording, and the results are set out in eight graphs. W. H. Gr.

1670. *The Magnetic and Electric Survey of the Earth.* **J. A. Fleming.** (Washington Acad. Sci., J. 16, pp. 109–132, March 4, 1926.)—This lecture is devoted to an account of the distribution of observatories over the surface of the globe and to the work they carry out. Some of the principal results so far obtained are indicated, and the possibility of further results from better and more numerous observations is considered. A. A. D.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

1671. *Ionisation Measurements of X-Rays incident per Unit Area and of X-Rays absorbed per Unit Volume.* **M. de Laroquette.** (Comptes Rendus, 182, pp. 771–773, March 22, 1926.)—An arrangement is described in which the ionisation vessel has only 1 sq. cm. of its surface exposed to X-radiation. This chamber is used to determine the absorption per unit volume of X-rays when traversing different media. Particular reference is made to the applications of the "ionmeter" in the study of radiotherapy. A. B. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1672. *Apparent Viscosity of Colloidal Solutions and a Theory of Neutral Colloids as Solvated Micelles capable of Aggregation.* **J. W. McBain.** (J. Phys. Chem. 30. pp. 239–247, Feb., 1926.)—The various ways of explaining the high viscosity of colloidal solutions, suspensions and emulsions compared with the viscosity of the solvent are discussed, and evidence is cited in support of the view that the apparent viscosity is not the true viscosity even when fully reproducible. The author's work on soap solution has established the fact of aggregation of molecules to form a colloidal unit or micelle. It is considered that the linking together of the colloidal particles or micelles to form larger structures is caused by bonds of union at least as local and specific as the processes operative in adsorption or residual affinity. These bonds are loosed by the substitution in them of various chemicals. This generalised form of solvation is the essential factor in gelatinising and dissolving nitro-cotton, and in explaining the apparent viscosity of the resulting systems. Only when aggregation is on an excessively coarse scale can mechanical means be effectively employed towards breaking it down. Otherwise, the one great operative force to be taken into account is the solvation, physical or chemical, or both, of the molecules in the colloidal micelle. T. H. P.

1673. *Influence of Ions carrying the Same Charge as the Dispersed Particles in the Inversion of Emulsions.* **S. Ghosh** and **N. R. Dhar.** (J. Phys. Chem. 30. pp. 294–305, March, 1926.)—The inversion of oil in water to water in oil emulsions brought about by the addition of various electrolytes was studied and discussed. The results obtained by other investigators were criticised, and the general theory of the inversion change, the effects of the various relative potency of the ions in their ability to reverse the stable water in oil type to oil in water type are given. F. J. B.

1674. *A New Method for the Determination of the Molecular Weight of the Proteins.* **T. Svedberg** and **R. Fåhraeus.** (Am. Chem. Soc., J. 48. pp. 430–438, Feb., 1926.)—A method is described for the determination of the molecular weight of proteins based upon the measurement of sedimentation equilibrium in solutions exposed to a centrifugal force. After centrifuging for definite intervals, microphotometric measurements are made, and curves are constructed which give the relation between the concentration of the solution and the distance from the centre of rotation. The following expression is derived to represent the molecular weight M when the sedimentation is in a state of equilibrium:

$$M = 2RT\ln(c_1/c_2)/\omega^2(1 - V\rho)(X_1 - X_2)(X_1 + X_2),$$

where c_1 and c_2 are the concentrations of the solution at two points situated X_1 and X_2 cm. from the centre of rotation, ω the angular velocity of the centrifuge, ρ the density of the solvent, and V the partial specific volume of solute. Closely agreeing values of 4 × 16,700 are obtained for the molecular weight of haemoglobin in determinations made under varying conditions. The constancy of molecular weights calculated from measurements of the central and peripheral parts further support the view that at least in one and the same solution there is practically only one kind of haemoglobin molecule. [Abstract 1237 (1925).] J. N. P.

1675. *The Structure of Gels.* **P. Thomas** and **Marie Sibi.** (Comptes Rendus, 182. pp. 314–316, Feb. 1, 1926.)—The dibenzoic ester of sorbite, $C_6H_{12}O_4(C_7H_5O)_2$, is soluble in 1000 parts of water at 100° C., and on cooling gives a transparent gel. Practically neutral water is necessary for the solution of this body, and the solubility is hindered by the presence either of acid or alkali. Comparative measurements are made of the velocity of diffusion of several dyes in this and other gels. On sufficiently prolonged agitation the dibenzoic ester of sorbite gel breaks down and gives visible white structureless flakes which float on the surface. When examined under the polarising microscope the gel appears entirely isotropic, while the separated flakes give faint polarisation images and appear anisotropic. On covering the transparent gel with a layer of acetone or alcohol and allowing to stand the surface of separation develops small white masses composed of a fringe of fine hair-shaped crystals. With some covering liquids a retraction of the gel occurs which behaves like an osmotic cell provided with a partition which allows the diffusion of water. The observations made lead to the conclusion that the gel investigated has a structure composed of a net of fine crystals capable of retaining in their meshes a large volume of water. J. N. P.

1676. *Inter-ionic Attraction Theory of Ionised Solutes. V. Testing of the Theory of Solubility Experiments at Higher Temperatures.* **W. P. Baxter.** (Am. Chem. Soc., J. 48. pp. 615–621, March, 1926.)—The results are given of measurements of the solubility of silver iodate at 75° in pure water (solubility = 0·00084 M), and in presence of potassium perchlorate, nitrate and sulphate, and of magnesium sulphate and barium nitrate, at concentrations from 0·0002 to 0·1 M. As far as the ionic concentration 0·01 M, the results conform almost perfectly with Debye and Hückel's limiting equation, and supplement Brönsted and la Mer's work [Abstract 1608 (1924)] in verifying the ion-attraction theory at very low concentrations. Not only is the predicted functional relation between activation and concentration shown to be correct, but the numerical coefficient of the equation is that required by the theory. At higher ionic strengths the observations exhibit the usual deviations in the direction of excessive mean activation values. Thus, at the ionic strength 0·08 M in presence of potassium perchlorate, nitrate and sulphate, and of magnesium sulphate, these values differ from the value 0·701 given by the limiting expression for zero concentration by 8·7, 6·1, – 0·3, and 6·0 % respectively. Since these experiments were made at 75°, and the earlier ones at room temperature [see Abstracts 2771, 2772 (1925)], the results furnish confirmation of the theoretical effect of varying the temperature, and of the concomitant variation of the dielectric constant in the case of the solvent water. T. H. P.

1677. *Smokes as Aerial Colloids.* **R. Whytlaw-Gray.** (Nature, 117. pp. 201–202, Feb. 6, 1926.)—An account is given of measurements of highly-dispersed aerosols that are near the limit of microscopic observation and within the range of the ultramicroscope. Fine oxide smokes composed of non-volatile materials are employed. The main points of distinction of these aerosols from hydrosols is that the former even when dilute are continually undergoing spontaneous aggregation, and the charged particles in these smokes are never all of the same sign, but usually oppositely-charged units are present in equal numbers so that the smoke as a whole is neutral. Uncharged particles are, moreover, invariably present, and in some cases far outnumber the charged particles. An account is given of the electrical condition, rate of fall and gas adsorption. Through the formation of aggregates, consisting of units not actually in contact but separated from each other by minute interfaces filled with air, the true radii of the majority of smoke particles are much larger than has been supposed, and, even in fine smokes, usually exceed 3×10^{-5} cm. The smoke particles appear to be a system of primary units in dynamic equilibrium under the opposing forces of Brownian agitation and electrical or cohesional attraction. J. N. P.

1678. *The Movement of Colloidal Particles in an Alternating Electric Field of Varying Frequency.* **O. Blüh.** (Ann. d. Physik, 79. 2. pp. 143–144, Feb. 18, 1926.)—A modification is made in the mathematical derivation of the amplitude of a charged colloidal particle in an alternating electric field as developed in an earlier investigation [Abstract 655 (1926)]. According to this expression $H\nu = C(1 + \alpha\sqrt{\nu})$, where H is the amplitude of the particle, ν the frequency of the field, and $\alpha = \sqrt{a/2\mu}$, where a is the radius of the particle. The measured results of amplitude at varying frequencies agree with this expression, and the above formulæ enable a calculation to be made of the radius of the particles. J. N. P.

1679. *Solubility Products of Mercury Halides in Water.* **A. E. Brodsky and J. M. Scherschewer.** (Zeits. Elektrochem. 32. pp. 1–4, Jan., 1926.)—The very small solubilities of mercurous halides cannot be determined directly, and the figures deduced by other workers from conductivity and cell measurements are discordant. The authors find that a solution of $Hg_2(NO_3)_2$, containing 0·0466 mol. $Hg^{\cdot\cdot}$ and 0·05 $H^{\cdot}$ kept unchanged for months when diluted with 2, 4 . . 128 volumes of water. They determine the e.m.f. of cells $Hg—Hg_2(NO_3)_2c_0—KNO_3$ sat.—$KXcHg_2X_2—Hg$, where X stands for Cl or Br, by a bridge-compensation method within 0·0001 volt at 11, 15, 19, 26·5° C. and different concentrations. The solubility product of Hg_2Cl_2 rises from 2×10^{-19} at 11° to $12 \cdot 2 \times 10^{-19}$ at 26·5°; that of Hg_2Br_2 is $5 \cdot 7 \times 10^{-23}$ at 26·5°. The relations are regular, but at very high dilution some hydrolysis seems to set in, the sooner the higher the temperature. These figures do not agree with those of others, but agree with direct measurements of their own and of Bugarsky on cells of the Hg_2Cl_2KCl type. H. B.

1680. *The Validity of Nernst's Osmotic Theory for Non-aqueous Solutions.* **A. E. Brodsky.** (Zeits. Elektrochem. 32. pp. 5–6, Jan., 1926.)—Experimenting with concentration cells of the type—

$$^{+}Hg \,.\, Hg_2Cl_2 \,.\, KClc_1—KClc_2Hg_2Cl_2—Hg^{-} \text{ (Cl or Br)}$$

in 50 % ethyl alcohol and absolute methyl alcohol, the author finds the presumed applicability confirmed except as to one obscure point. The dissociation of KBr and KCl remaining practically unchanged, and the same as in water, on diluting the alcohol, the e.m.f. of the chains should not have been affected by that concentration; but it became smaller as the dilution increased. H. B.

1681. *The Influence of Minute Traces of Water on Solution Equilibria.* **E. Cohen and S. Miyake.** (K. Akad. Amsterdam, Proc. 28. 10. pp. 936–941, 1925.)—Solubility measurements are made at 30·50° C. under conditions which ensure that true equilibrium values are obtained. The solubility of salicylic acid in benzene increases from 1·00 % (gm. solute in 100 gm. solution) in the absence of water to 1·19 % when 0·071 % of water is present. In chloroform the solubility of salicylic acid increases from 1·55 % in the dry solvent to 1·72 % in that containing 0·108 % of water. Marked increases in solubility by the presence of water are also observed with *o*-nitrobenzoic acid in benzene and in chloroform. With salicylic acid in carbon tetrachloride, the solubility remains constant at 0·36 % both with dry solvent and with that saturated with water. The solubility of the non-electrolyte anthracene in benzene is also unaffected by water. [See Abstract 622 (1926).] J. N. P.

1682. *Nuclei Formation in Supersaturated States.* **M. Volmer** and **A. Weber.** (Zeits. phys. Chem. 119. pp. 277–301, March 8, 1926.)—The authors commence with a theoretical treatment of nuclei formation in supersaturated (metastable) states based on the thermodynamical considerations of Gibbs. Since the existence of such metastability has been already shown to depend on the work of capillarity involved in the formation of a new phase, the authors have worked from this standpoint and submit two modes of mathematical treatment. A comprehensive experimental review then follows dealing with liquid nuclei and with crystal formation from vapours, solutions, fusions and crystalline phases, the latter being important for metals. The paper is replete with experimental detail and attendant data. H. H. Ho.

1683. *Solubility of Salts.* **V. Macheleidt.** (Zeits. Elektrochem. 32. pp. 129–136, March, 1926.)—A graphical mathematical study of the solubility of salts and the factors which influence the solubility. The solubility curves and the equations of the curves are developed, and the maximum error is calculated. The paper is not suitable for abstracting, and the original must be consulted for details. F. J. B.

1684. *The Arrhenius Equation relating Osmotic Pressure with Elevation of Boiling-point.* **K. Schreber.** (Zeits. Elektrochem. 32. pp. 149–150, March, 1926.)—A modification is made in the Arrhenius equation which relates the osmotic pressure of a solution with the difference in vapour-pressure of solute and solvent. An allowance is made for an assumed difference in temperature over the surface of the solution at the high level of the osmometer, or θ_l and the temperature of the vapour above the solvent θ_m which is the same as the temperature of the solvent. From the formula $\pi = hs$, where π is the osmotic pressure, h is the height of the level of the solution in the osmometer above that of the solvent and s is the density of the solvent, the Arrhenius formulæ are modified to give the expressions :

$$h = \frac{r}{A} \frac{\theta_m - \theta_l}{\theta_m} \quad \text{and} \quad \pi = \frac{rs}{A\theta_m} (\theta_m - \theta_l).$$

where r is the molecular concentration of the solute and A that of the solvent. J. N. P.

1685. *Spectrographic Study of the Potassium Trihalogens.* **P. Job.** (Comptes Rendus, 182, pp. 632–634, March 8, 1926.)—Employing the method previously described [see Abstract 2385 (1925)], the equilibrium constants at 16° C. and the affinity in calories of the halogen molecule for the halogenated ion in aqueous solution at 16° C. are determined for the complexes I_3K, Br_3K, I_2BrK, Br_2ClK, I_2ClK. A. B. C. L.

1686. *The Heat of Dilution of an Ionic Solution on the Theory of Debye and Hückel.* **N. Bjerrum.** (Zeits. phys. Chem. 119. pp. 145–160, March 8, 1926.)—This paper has for its object the extension of the theory of Debye and Hückel relating to strong electrolytes in order to make the expression for the heats of dilution thermodynamically compatible with the formula for the activity coefficients. Reference is made to the work of Gross and Halpern [see Abstract 2821 (1925)], which deals with similar problems. The expression for the heat of dilution in the theory of Debye and Hückel is first derived thermodynamically. This value of the heat of dilution is explicable atomistically when it is realised that the thermal molecular movements by dilution of an ionic solution assist in the separation of the ions whereby energy must be lost, and, further, that these thermal molecular movements by the straining of a dipole dielectric cause an alteration of the dipole orientation whereby additional energy is lost. In consequence the author next develops a thermodynamical and atomistic theory of thermal effects in dielectrics for field alterations. It is shown that Debye's two different processes for the derivation of a formula for the ionic activity coefficients lead to one and the same formula when the correct value for the heat of dilution is employed. A comparison with existing experimental data shows that the formula established for the heat of dilution is not valid for concentrations at which the measurements have been hitherto undertaken. This experimental data, however, appears not to be incompatible for the utility of the formula for 0·01 mol. solution. H. H. Ho.

1687. *Distribution of Particle Size in Dispersed Systems.* **A. Gyemant.** (Zeits. f. Physik, 36. 6. pp. 457–466, 1926.)—In a highly-dispersed colloid, increase in the particle size by aggregation tends to be brought about on account of the bounding surface-tension between the dispersed phase and the dispersion medium, while the influences of the electrical charge and of solvatation tend to increase the degree of dispersion. In an equilibrium state a balance is present between these factors. Aggregation of a highly-dispersed colloid occurs with a resulting increase in the potential energy due to the increase in the charge until the equilibrium between the opposing forces is reached when a stable system results. The potential energy is expressed as a function of the radius of the particle. The condition which determines that two particles cohere on collision is that the molecular cohesive force overcomes the electrical repulsion and is given by the expression :

$$\frac{1}{R_1}+\frac{1}{R_2}>8S\left(2d-\sqrt[n+1]{c}\,\frac{4d^2\epsilon nx}{\nu^2e^2\left(\frac{S}{S_0}\right)^2}\right),$$

where R_1 and R_2 are the radii of the two particles, S is the concentration of ions and S_0 that of molecules per unit surface, ν the valency and e the ionic charge, ϵ the dielectric constant of water, d the thickness of the hydration layer and n the number of individual particles which enter in the formation of an aggregate. With highly-dispersed sols the value of x becomes small and the expression may be reduced to $\frac{1}{R_1}+\frac{1}{R_2}>16Sd$. Relations are deduced mathematically for the distribution of particle size as a function of time. In a number of instances the value of the charge on the particles calculated from the formulæ derived agrees satisfactorily with that determined by other methods. J. N. P.

1688. *Physical Properties of Ultra-light Magnesium Alloys.* **A. Portevin and F. le Chatelier.** (Comptes Rendus, 182. pp. 382–384, Feb. 8, 1926.)—A description and results are given of a series of determinations of the density, thermal expansion and electrical resistance of very light magnesium alloys—the alloys being formed with various metals, Al, Cd, Sn, Mn, Ni, Pb, Si and Zn. The electrical conductivity was measured as an indication of the thermal conductivity, as these physical quantities exhibit a close parallelism, and the electrical quantity permits of easier measurement. The original paper should be consulted for detailed results. **Errata** (*ibid.*, p. 732, March 15, 1926). A. B. W.

1689. *Cementation of Ferrous Alloys by Tungsten.* **J. Laissus.** (Comptes Rendus, 182. pp. 465–467, Feb. 15, 1926.)—Steels of various carbon content are cemented with finely-powdered ferrotungsten at temperatures from 800° C. to 1100° C. on lines similar to those described for chromium [see Abstract 2386 (1925)]. Tabulated results of thickness of cemented zones and attack of the cemented surfaces show that cementation with tungsten affords in general more than double the advantage obtained by cementation with chromium. The rate of formation of the brilliant external layer is greater at higher temperatures and with lower carbon content of the steel being cemented. A. B. C. L.

1690. *Phosphor-Bronze. Optical Investigation of the System Copper-Phosphorus-Tin. Part* 2. **L. C. Glaser and H. J. Seemann.** (Zeits. techn. Physik, 7. 2. pp. 90–92, 1926.)—The previous work [see Abstract 1151 (1926)] on copper-phosphorus-tin is continued. The structure of the eutectic consisting of copper 80·7 %, phosphorus 4·5 %, tin 14·8 % was examined, and the results of the earlier thermal analyses were confirmed. All the specimens were examined with ordinary illumination and with polarised light. The results of the optical investigation of the structures confirm the existence of a ternary eutectic, and in the α copper mixed crystals the compound Cu_3P is recognised as a constituent, together with a compound of copper-tin, which requires further investigation. These three components are all present in technical phosphor-bronze. A number of photomicrographs are given in the paper. F. J. B.

1691. *The Effect of Heat Treatment upon Alloys of Silver-Zinc and Silver-Cadmium.* **L. Guillet and J. Cournot.** (Comptes Rendus, 182. pp. 606–609, March 8, 1926.)—In the silver-zinc alloys an increase of hardness is brought about by suitable annealing, an effect analogous to that found in duralumin. In the case of silver-cadmium alloys the increase of hardness is less evident. In both cases doubt is thrown on the exactitude of the accepted constitutional diagrams. A. A. D.

1692. *Composition of Copper "Mattes."* **B. Bogitch.** (Comptes Rendus, 182. pp. 468–470, Feb. 15, 1926.)—In the study of the system Cu_2S, FeS, Fe, Cu, in the liquid state, it is found that successive additions of Cu to mixtures of Fe and FeS, which in the liquid state are miscible in all proportions, produce segregation up to 8 % Cu, after which two liquid layers form, S tending to concentrate in the upper layer. The greater part of the Cu passes into the upper layer until a Cu concentration of about 50 % is reached, from which to 94 % Cu the upper layer suffers very little alteration in composition. The upper layer then again receives further additions of Cu. An equilibrium diagram of the ternary system Cu, Fe, S is given and briefly interpreted with reference to the practical treatment of Cu "mattes." A. B. C. L.

1693. *Sublimation and Crystallisation of Metals.* **T. Peczalski.** (Comptes Rendus, 182. pp. 516–517, Feb. 22, 1926.)—Experiments on cementation of metals by salts [see Abstract 403 (1926)] continued. Metals in contact with chlorides sublime on heating; the vapours of the metals come from reduction of their chlorides. It seems that the cementation of metals by salts arises from absorption of the vapours of the salts. A. D.

1694. *Reaction-Velocity and Thermodynamics.* **E. Jouguet.** (Ann. de Physique, 5. pp. 5–72, Jan.–Feb., 1926.)—The coordination of suggestions by various authors with regard to reaction-velocity on a thermodynamic basis is attempted. Starting from Duhem's conception of chemical viscosity, an appropriate hypothesis is developed embracing the splitting of a reaction into two inverse reactions, in accordance with and illustrating Nernst's views on affinity and chemical resistance. Marcelin's formula for reaction-velocity, for which a convenient new form is expressed, is then introduced and discussed. A. B. C. L.

1695. *Nature of the "Critical Increment" of Chemical Action.* **T. C. Sutton.** (Phil. Mag. 1. pp. 606–608, March, 1926.)—Kinetic considerations lead to the conclusion that, when activated molecules collide, even if they approach in the actual line of centres, their energy distribution is by no means fixed. There will be some collisions with translational energy suitable for reaction, but with rotational and internal molecular energy unsuitable, and also some with suitable internal but unsuitable translational energy. Thus, there must be many collisions between such activated molecules which do not result in chemical interaction in the ordinary sense [see Abstract 1076 (1915)]. This is substantially the view advanced by Garner on other grounds [see Abstract 407 (1926)]. T. H. P.

1696. *The Law and Mechanism of Monomolecular Reaction.* **S. C. Roy.** (Roy. Soc., Proc. 110. pp. 543–560, March 1, 1926.)—Largely mathematical. The rôle of radiation in photochemical and thermochemical reactions is discussed. The monomolecular decomposition of the compound AB is considered: if the molecule requires preliminary activation before decomposition can occur, the breakdown is represented by $[AB]_n \longleftrightarrow ([AB]_a \longleftrightarrow [A]_a + [B]_a) \longleftrightarrow [A]_n + [B]_n$, where $[\ ]_n$ and $[\ ]_a$ signify the normal and activated states. The processes of dissociation and recombination of the activated molecules are assumed to be governed by the unit mechanism $h\nu \longleftrightarrow \frac{1}{2}\mu v^2 + \phi$, where μ is the "reduced" mass equal to $m_A \cdot m_B/(m_A + m_B)$. v is the relative velocity with which the two components of AB shoot out by absorption of a radiation quantum, and ϕ is the energy required to disrupt the molecule. The radiation effective in producing dissociation is supposed to consist of the whole range of frequencies above a certain critical value. The expression deduced for the rate of monomolecular reaction is

$$K = \frac{8\pi k^2 m_H}{h^3} \cdot \left(\frac{AB}{A + B}\right) \cdot \frac{\bar{\beta}_0}{a} T \cdot \epsilon^{-(Q_a^{AB} + Q_0)/RT}$$

where A and B are the molecular weights of the components, $\bar{\beta}_0$ is identified with the cross-section of the reacting molecule, a is a statistical weight factor determined by the number of valency bonds between the components, Q_a^{AB} and Q_0 are the heats of activation and dissociation of AB. The expression is shown to agree with existing experimental data for some monomolecular reactions in the gaseous state and in solution. L. M. C.

1697. *Evidence for the Existence of Activated Molecules in a Chemical Reaction.* **O. R. Wulf.** (Nat. Acad. Sci., Proc. 12. pp. 129–132, Feb., 1926.)—The application of the quantum theory to the radiation emitted when ozone is transformed into oxygen, necessitates the assumption that ozone, under conditions favourable to its decomposition, contains molecules in activated states of much higher energy content than that of the normal molecule. J. S. G. T.

1698. *Reactions between Colloidal Particles and Solutions.* **K. F. Herzfeld.** (Zeits. phys. Chem. 119. pp. 377–381, March 25, 1926.)—The kinetics and equilibria of reactions occurring between colloidal dispersions and molecular solutions are investigated. The colloids considered include dyes and crystallites or amorphous colloidal particles in which, as with cellulose and silk fibres, X-ray analysis has revealed a lattice structure. With heterogeneous reactions the two phases are characterised by a sharp line of separation. The reaction rate is determined by the concentration of the dissolved substance and the surface of the micelles. The change of the reaction rate with time depends on the form of the particles, and is of a monomolecular type when the colloid is present in large excess. Formulæ are derived to express the reaction rate when the reactants are present in equivalent amounts and with homogeneous reactions which are conditioned by the reaction product being in solid solution in the unattacked colloid. Disturbing factors in the kinetics of heterogeneous reactions are exerted by particle size and by adsorption. [See Abstract 1084 (1921).] J. N. P.

1699. *The Decomposition of Nitrogen Pentoxide. Infra-red Radiation.* **H. A. Taylor.** (Am. Chem. Soc., J. 48. pp. 577–582, March, 1926.)—Nitrogen pentoxide, prepared from nitric acid and phosphorus pentoxide and containing, although purified, possibly some nitrogen tetroxide, which is not assumed to affect the reactions, is exposed to radiations from a carbon arc of 7 amps. at 110 volts. The light is passed through a sheet of biotite mica, 0·12 mm. in thickness, which practically transmits only rays between 2 μ and 8 μ; this range includes the two absorption bands of the nitrogen pentoxide at 3·4 and 5·8 μ. The slight decomposition observed could be accounted for by the rise of temperature, about 5° in two hours; a reaction vessel of quartz was used. In similar experiments with hydrogen and ethylene, heated within their quartz vessel to 300° and exposed to the full radiation from a Nernst glower for forty-eight hours, the decomposition of the ethylene was also very slight. As the decomposition of nitrogen peroxide is regarded as unimolecular and not appreciably catalysed by the walls of the container, the importance of radiation in unimolecular reactions is questioned. H. B.

1700. *Photochemical Inactivity of Infra-red Radiation, with Special Reference to the Decomposition of Nitrogen Pentoxide.* **F. Daniels.** (Am. Chem. Soc., J. 48. pp. 607–615, March, 1926.)—The decomposition of nitrogen pentoxide, which is a homogeneous gas reaction and truly unimolecular, is utilised to ascertain if infra-red radiation is photochemically active. The results obtained show that at least 99·5 % of the infra-red radiation absorbed by the pentoxide is chemically inactive towards the gas. A slightly increased decomposition occurring at room-temperature disappears at 0° and is ascribed to thermal influences. Infra-red radiation is inactive also in the decomposition of carbon dioxide or gaseous hydrogen chloride and in the oxidation of alcohol vapour. T. H. P.

1701. *Fourth Report of the Committee on Contact Catalysis.* **H. S. Taylor.** (J. Phys. Chem. 30. pp. 145–171, Feb., 1926.)—In this report no attempt is made to give a complete survey of the literature published on catalysis during the year. The problems of contact catalysis as set forth in the First Report are, however, reviewed in order to estimate how far these problems have now progressed towards a definite solution. With regard to the mechanism of catalytic action, a theory of the catalyst surface of variable activity is discussed, and the supporting evidence and the consequences indicated. Other questions considered are; promoter action, the effect of heat treatment of catalysts and specific activation. T. H. P.

1702. *Mechanism of the Fusion of Coal.* **E. Audibert.** (Comptes Rendus, 182. pp. 316–318, Feb. 1, 1926.)—It is found on heating quickly to a definite temperature varying from 325° to 420° C. any type of coal containing over 14 or 15 % volatile matter that softening or incipient fusion occurs, and the material agglomerates to form a compact mass or coke. On raising the temperature progressively at definite rates the point of commencement of fusion is raised, and the melting becomes less and less complete as the heating is slower. Below a certain rate of heating, the value of which varies with the type of coal, fusion no longer occurs, and the grains do not weld together. With all types of coal which are employed industrially for coking the minimum rate of heating necessary for coke formation is less than 1° per min. At temperatures slightly below those of fusion chemical interactions or pyrogenation of the coal begins and progresses slowly, while the fusion at the somewhat higher temperature is rapid. The eventual agglomeration of the mass necessary for coking requires that this pyrogenation be not too far advanced before fusion is brought about. J. N. P.

1703. *Gaseous Combustion at Medium Pressures. Part I. Carbon Monoxide-Air Explosions in a Closed Vessel. Part II. Methane-Air*

Explosions in a Closed Vessel. **R. W. Fenning.** (Roy. Soc., Phil. Trans. 225. pp. 331–356, Jan. 5, 1926.)—Part I. The addition of hydrogen-air mixtures to carbon monoxide-air mixtures produces a progressive decrease in the explosion time, hydrogen-air mixtures alone exploding the most rapidly. Cooling commences almost immediately after the attainment of the maximum with hydrogen air, but with carbon monoxide the cooling is delayed appreciably, showing energy is still being liberated, and the rate of cooling is slower. The addition of water-vapour in small quantities appreciably diminishes the explosion time for carbon monoxide-air mixtures.

Part II. The explosion time for methane-air mixtures is a minimum with 9·7 % methane, corresponding closely to a "complete combustion" mixture. The explosion time is increased by increasing the charge density, decreasing the initial temperature or diluting the mixture with water-vapour or exhaust gases. The experiments covered a range of initial temperatures from atmospheric to 400° C., and pressures of 2 to 5 atmos. B. W. C.

1704. *Formation of Ozone and Hydrogen Peroxide in the Hydrogen-Oxygen Flame.* **E. H. Riesenfeld** and **H. v. Gündell.** (Zeits. phys. Chem. 119. pp. 319–332, March 25, 1926.)—Hydrogen issuing from a quartz capillary of 0·193 mm. diameter [Abstract 2625 (1925)] is burnt by a microflame in an excess of oxygen within a tubular cooler made of glass and quartz. With efficient cooling the reaction yields only water and hydrogen peroxide. If there were complete equilibrium the reactions could be represented by a closed cycle:

$$H_2 + O_2 \leftrightarrows H_2O_2 \rightleftarrows H_2O + \tfrac{1}{2}O_2 \rightleftarrows ;$$

But the time is probably insufficient for the establishment of equilibrium; the law of mass action may be inapplicable, and the apparent agreement between the calculated temperature of the well-cooled flame (1500° to 1550°) and Nernst's formula may be accidental. The formation of ozone takes place outside the flame and only when the quenching of the gases is insufficient to prevent decomposition of the hydrogen peroxide. This decomposition yields water and atomic oxygen; whether the latter atoms will combine to molecular oxygen, or combine with the excess of molecular oxygen present to ozone depends upon the proportions. A strong excess of molecular oxygen favours the ozone formation; a deficiency prevents it even with insufficient quenching. H. B.

1705. *Velocity of the Reaction $2NO + Cl_2 = 2NOCl$ in a Magnetic Field.* **F. A. Henglein.** (Zeits. Elektrochem. 32. pp. 213–215, April, 1926.)—According to Pinkus, this reaction is accompanied by ionisation [Abstract 1442 (1919)], at any rate during the initial stages of the reaction in the presence of an excess of chlorine. According to Trautz, the velocity is, however, uniform throughout the reaction. If ions and electrons were formed, the velocity of the reaction should change in a magnetic field. The author did not observe any change when a field of 20,000 gauss was turned on or off. H. B.

1706. *The Law of Photochemical Equivalence applied to Photosynthesis by Chlorophyll.* **R. Wurmser.** (J. de Physique et le Radium, 7. pp. 33–44, Feb., 1926.)—The amount of carbon dioxide reduced by the alga *ulva lactuca* on exposure to light is determined by a manometric method for two regions of the spectrum (5900–4900 Å. and 7000–5900 Å.): the amount of energy taken in by the alga is measured, and the percentage of this energy which is actually absorbed by the chlorophyll pigment (the remainder being lost through diffusion in the colourless portions of the material) is calculated on the basis of a mathematically derived formula, which is experimentally verified. Previous considerations (Ann. de Physiol. et Physicochim. Biol., 1. p. 47, 1925) show that photosynthesis comprises a series of reactions, of which the initial one only is photochemical in nature. With light of very small intensity, the velocity of the initial reaction determines the velocity of the complete reduction: radiation of little intensity is therefore used in these experiments. Einstein's law of photochemical equivalence cannot be applied in its simple form to photosynthesis by chlorophyll, since the ratio of the amount of carbon dioxide reduced to that of the energy absorbed is not inversely proportional to the mean frequency of the spectrum range employed. The ratio of the amounts of reduction for unit absorption of energy in the two spectrum regions considered is 1·146, while the inverse ratio of the frequencies is 0·82. (See O. Warburg and E. Negelein, Zeits. phys. Chem. 106. p. 191, 1923.) L. M. C.

1707. *Electromotive Force of Accumulators and Strength of the Acid.* **K. Schreber.** (Zeits. Elektrochem. 32. pp. 143–149, March, 1926.)—The electromotive force of accumulators with different strengths of acid was calculated with the aid of published data. It was found that the result obtained for the e.m.f. of two accumulators in series with different strengths of acid agreed with the values obtained experimentally when the calculation was made by Faraday's method, while the calculation according to Gay-Lussac gave too high a value. From the results it follows that the solution yields saturated vapour. F. J. B.

1708. *Hydrogen Electrode Studies of the Precipitation of Basic Chromates, Borates and Carbonates.* **H. T. S. Britton.** (Chem. Soc., J. pp. 125–147, Jan., 1926.)—Precipitation of basic salts containing weak acid radicles—*e.g.* chromates, borates and carbonates—takes place at the same values of *p*H as the precipitation of the corresponding hydroxides; with zirconium and thorium chloride solutions cases of delayed precipitation were observed. The precipitability of the different bases as basic salts depends on the capacity of the precipitant to produce the value of *p*H at which the hydroxide is precipitated [Abstract 201 (1926)], and when such value is only just attained the precipitation is partial. T. H. P.

1709. *Electrometry of Precipitation Reactions.* **J. A. Athanasiu.** (Comptes Rendus, 182. pp. 519–521, Feb. 23, 1926.)—The use of a mixture of absolute alcohol 30 with water 70, instead of pure water as a solvent, exercises a manifest influence over precipitation reactions, and the observed potentiometric curve then coincides with the theoretical curve. A. D.

1710. *The Technique of Electrometric pH-Determinations.* **H. Menzel** and **F. Krüger.** (Zeits. Elektrochem. 32. pp. 93–97, Feb., 1926.)—In determining *p*H values by a hydrogen electrode, a calomel electrode with 3·5 N potassium chloride is employed as the comparison electrode and a capillary electrometer as a null instrument. A Pt-Ir wire of 0·10 mm. diameter and 1 metre long, with a total resistance of 41·3 ohm, is used as a bridge. Special steel wires, which are now available for bridges, are found to be uniform to a high degree. The difficulty present when measuring solutions of high resistance is minimised by employing for the capillary electrometer a tube of round and moderately large section (0·8 mm.). With these capillaries the displacement for a given change of potential is less than with narrower tubes, but the movement is quicker. The tube connecting the electrolytes around the two electrodes is filled with a solution of potassium chloride which is set in an agar gel. A modified form of the Michaelis dipping hydrogen electrode is applied to the testing of electroplating solutions. Fluctuations of potential are produced by it according to the speed of passage of the hydrogen and the rate of circulation of the electrolyte. These departures are attributed to incomplete saturation of the electrode by the hydrogen. It is concluded that the dipping electrode in this form is unsuited to exact *p*H-determinations, but that it can usefully be employed in electrometric titrations. A type of vessel which has been devised for precise *p*H-determinations is described and illustrated, and contains an electrode of platinum- or iridium-plated gold wire mounted in a vessel into which the liquid to be measured can be displaced. J. N. P.

1711. *Variation of the E.M.F. of a Photo-active Cell containing a Fluorescent Electrolyte, when the Amount of Fluorescent Material in Solution is Varied.* **W. Rule.** (Phil. Mag. 1. pp. 532–541, Feb., 1926.)—Measurements were made with NaOH solutions containing fluorescein in different concentrations, and later eosin in glycerine and water. The solution was contained in a glass tube between Pt electrodes, one of which was in the form of a flat spiral. The solution near the spiral was illuminated with the help of a Hg-arc lamp, and the variation of the e.m.f. with time determined. The pure NaOH solution gave no measurable e.m.f., thus disproving Grumbach's contention that the action on the electrode of the fluorescent radiation produced part of the e.m.f. [see Abstract 1262 (1923)]. It was found that the e.m.f. generated in a given time rises rapidly to a maximum as the concentration of the fluorescent substance is increased, and then falls off slowly. Analogous behaviour, such as the conductivity of these solutions for different concentrations, phosphorescence and fluorescence are discussed, and a theoretical explanation given for the change of e.m.f. with time and concentration for these fluorescent electrolytes. R. S. R.

1712. *Critical Potentials of Hydrogen in the Presence of Catalytic Nickel and Copper.* **J. H. Wolfenden.** (Roy. Soc., Proc. 110. pp. 464–476, Feb. 1, 1926.)—Criticisms are advanced which seem to invalidate Gauger's measurements of the critical potentials of hydrogen in presence of catalytic nickel [Abstract 1620 (1924)]. A modified apparatus is described in which measurements were made of ionisation from hydrogen in presence of catalytic nickel, plain nickel, and catalytic copper. Comparison of the results obtained with those furnished when molecular hydrogen is the preponderating source of ionisation leads to the conclusion that substantial quantities of atomic hydrogen are present at the metal surface in each of the three former cases. A similarity is found between the effect produced on the form of the ionisation curve by the presence of the catalyst metal

and by that of an incandescent grid. These considerations are probably of significance in relation to the mechanism of catalytic hydrogenation.
T. H. P.

1713. *Electromotive Behaviour of Cupric Oxide.* **R. E. W. Maddison.** (Faraday Soc., Trans. 22. pp. 27–33, Feb., 1926.)—Various experimenters have found that cupric oxide electrodes are not steady. The author examines the behaviour of the electrode Pt/CuO, Cu_2O, N-NaOH, which gives initially a positive p.d. and becomes more negative in the course of weeks. The values and changes are found to depend upon the temperature of preparation of the oxide and on the duration and method of heating. Allmand [Abstract 1062 (1911)] had suggested several modifications of the oxide of which Hedvall [Abstract 508 (1923)] had not found any evidence by X-ray examination; these questions are left undecided.
H. B.

1714. *Electromotor Properties of Glasses.* **K. Horovitz.** (Akad. Wiss. Wien, Ber. 134. 2a. No. 7–8. pp. 335–354, 1925.)—Lead glasses have the relations of a H-electrode for all concentrations of hydrogen. With all these glasses additions of metal kations altered the e.m.f. The conductivity has no direct relation with the H-electrode function. With potash glasses the use of KOH instead of NaOH in the acid-alkali cell lowers the e.m.f.; the contrary with soda glasses.
A. D.

1715. *Interchange of Ions in Glasses.* **K. Horovitz** and **J. Zimmermann.** (Akad. Wiss. Wien, Ber. 134. 2a. No. 7–8. pp. 355–383, 1925.)—Hard glass takes up silver ions to such an extent that it can come to act as a reversible Ag-electrode. For each kind of glass and each kind of ion there is a particular concentration in the solution which brings about this reversible-electrode effect. Thermodynamic considerations require that on current passing from a silver nitrate solution into glass, silver should be taken up by the glass; this has been confirmed in Toronto by M. J. Mulligan.
A. D.

1716. *Electrometric Titration of Halides.* **W. Clark.** (Chem. Soc., J. pp. 749–775, April, 1926.)—The experiments are made by connecting the beaker containing the solution to be titrated and a silver electrode with a calomel cell, the e.m.f. of the combination being determined by means of a potentiometer after each addition of silver nitrate. This method can be used for the titration of mixed halides without changing the electrode or the constant half-cell. The calomel cell is of the saturated KCl type and united with the solution in the beaker by a bridge of saturated ammonium nitrate in such a way as to prevent diffusion of chloride into the beaker and displacement of the solution by the specifically heavier ammonium nitrate. The end-point of the titration is obtained either by plotting the titration curve of silver nitrate added against the e.m.f. or, more rapidly, by plotting the dE/dV against V; each method has advantages. The electrode has to be scraped clean and treated with nitric acid after each series. The solubilities of the silver halides are: AgCl 10^{-10}, AgBr 10^{-12}, AgI 10^{-16}, and in the titration curve of halide mixtures the breaks for the different halides follow one another in the opposite order. Very low percentages of bromide in chloride cannot be determined electrometrically. Silver halides can for analysis either be dissolved in cyanide, or the silver can be reduced either by sodium hydrosulphite (rarely free of chloride, however) or by zinc. The analysis of photographic emulsions is also noticed. The methods of other workers are critically discussed, with special reference to E. Müller [Elektrometrische Massanalyse and Abstract 1040 (1924)]; see also Willard and Fenwick [Abstracts 409 and 410 (1923)]. H. B.

1717. *Anomalies of Electrocapillarity Curves.* **E. Liebreich.** (Zeits. Elektrochem. 32. pp. 162–172, March, 1926.)—Electrocapillarity curves and current-potential curves are given for mercury in sulphuric acid, potassium nitrate, and sodium hydroxide solutions. The maximum of the electrocapillarity curves occurs at that part of the current-pressure curve which corresponds with the formation of hydroxides at the surface of the mercury. Further, in the above electrolytes, immediately after the maximum is passed, hydrogen is generated which frees the surface from the hydroxides. Hence the falling branch of the electrocapillarity curve corresponds with a metallic-bright mercury surface, and the rising branch and the maximum with a surface (electrode of the second type) coated with hydroxides (or basic salts). The cleansing of the surface begins at the maximum. The assumption is made that the anomalies of electrocapillarity curves are related to this phenomenon. Such a connection may possibly lie in a diminution of the surface-tension by partial solution of the hydroxides or basic salts in the mercury, or, more probably, in adsorption of the anions in question. T. H. P.

1718. *Transference Numbers of Sodium and Hydrogen in Mixed Chloride Solution.* **Millicent Taylor.** (Am. Chem. Soc., J. 48. pp. 599–603, March, 1926.)—In order to test Schneider and Braley's results [Abstract 2334 (1923)], which indicated the formation of a complex anion in a solution containing sodium and potassium chlorides, measurements have been made of transference numbers of sodium and hydrogen in solutions of sodium chloride containing hydrochloric acid. Complete agreement is found between the mean observed values of the transference numbers and the values calculated according to the normal behaviour of mixed salts in solution, so that the solutions examined contain only simple ions. T. H. P.

1719. *The Ionisation of the Strong Electrolytes.* **H. M. Dawson** and **J. S. Carter.** (Leeds Philosoph. and Lit. Soc., Proc. 1. pp. 14–16, Oct., 1925.)—Measurements are made over a wide range of concentrations of the combining capacity of iodine with sodium chloride to give the perhalide $NaClI_2$. Equilibria are determined at 25° C. by the solubility method. Use is made of the following relation expressing the solubility S of a non-electrolyte in an electrolyte of concentration C when chemical interaction between the non-electrolytes and electrolytes is excluded: $S = S_0 e^{-ac}$, where S_0 is the solubility of the non-electrolyte in the pure solvent and a is a constant which measures the salting-out effect of the salt. a is evaluated from the formula $a = \frac{1}{c} \ln \frac{S_0}{S_t}\left(1 + \frac{c}{K_0}\right)$, where S_t is the measured solubility of the iodine in the salt solution and K_0 is the dissociation constant of the perhalide when extrapolated to $C = 0$. The value thus determined for a is 0·281. The solubility of iodine is found to increase with the concentration of salt up to a maximum with a salt concentration of about 3N, and beyond this concentration the solubility decreases. In this region the effect of perhalide formation is more than counterbalanced by the salting-out influence of the sodium chloride. Approximately constant values are obtained for the calculated dissociation constant of the perhalide at different concentrations. The results indicate that the combining capacity of sodium chloride for iodine is the same whether the salt is present in dilute or concentrated solution, which suggests, in disagreement with the Arrhenius theory, that there is no difference in the nature and condition of the dissolved electrolyte when the concentration is varied between the widest possible limits. Support is thus given to the view that strong electrolytes are completely ionised in aqueous solution. [See Abstract 2328 (1923).] J. N. P.

1720. *Theory of Overvoltage.* **M. Knobel.** (J. Math. Phys., Mass. Inst. of Technology, 5. pp. 65–74, Feb., 1926.)—A theory of overvoltage is developed on the basis of a previous article [see Abstract 982 (1925)] and a series of experimental papers which have appeared since that time. The postulates of the theory of overvoltage are (1) that the atomic gas is the electromotively active substance and that the molecule has only an indirect effect by its influence on the atomic gas pressures; (2) that overvoltage is due to an excess surface concentration of this adsorbed atomic gas, and that this surface concentration is connected with the pressure by an equation of the form of Freundlich's isotherm. By means of these two postulates a mechanism of the action at polarised electrodes is obtained, which involves reasonable concentrations of the active substances at all overvoltages. The maximum overvoltage calculated for hydrogen agrees well with experimental results. The effect of different electrode materials and their surface condition on overvoltage is shown to be related to the adsorbing power of the material. An equation for the effect of current density is deduced, which approximately represents the experimental data. The effect of pressure on overvoltage is accounted for and agrees with experiment. A qualitative explanation for the effect on overvoltage of other factors such as stirring, temperature, and colloids, but owing to lack of data, details cannot be given. F. J. B.

1721. *The Penetration of Electrolytic Hydrogen through Iron.* **M. Knobel** and **R. B. Norton.** (J. Math. Phys., Mass. Inst. of Technology, 5. pp. 75–83, March, 1926.)—In a preceding paper, Knobel [Abstract 982 (1925)] has derived a theory of overvoltage from which an equation is now deduced for the rate of penetration of kathodic hydrogen through iron as a function of the hydrogen overvoltage. The present authors then present experimental data which are in accord with predicted values as far as variation with overvoltage is concerned, thereby confirming the mechanism of penetration proposed. H. H. Ho.

1722. *Electrolysis of Aqueous Solutions of Hydrochloric Acid.* **A. Hollard.** (J. de Physique et le Radium, 7. pp. 25–32, Jan., 1926.)—A solution of hydrochloric acid of a definite concentration is subjected to electrolysis in a large U-tube with a kathode of platinised platinum. Readings of the current are taken on gradually increasing the voltage which is measured by a potentiometer. With an electrolyte containing 6·3 gm. hydrochloric acid per litre and a platinum anode, inflection points or rises in the current curve are observed at 1·10 and 3·6 volts.

At the former point evolution of chlorine begins, and at the latter oxygen. Below 1·10 volts no gas is evolved at the anode, the residual currents being attributed to concentration changes, and between 1·10 and 3·6 volts chlorine alone is evolved. No hypochlorous acid can be detected under any conditions. With an electrolyte of 28·5 gm. hydrochloric acid per litre the inflection points are at 1·24 volts when chlorine separates, and 3 volts when oxygen separates. On electrolysing hydrochloric acid solutions of varying concentrations at a given voltage which is above 4 volts, the ratio of chlorine to oxygen evolved increases with increasing concentration, and with an anode of silver chloride this ratio is less than with a platinum anode. The oxygen is considered to arise from OH′ ions which are in equilibrium with undissociated water. The concentration of OH′ ions around the anode is increased through the accumulation of Cl′ ions, which suppress the concentration of H ions, and thus increase the OH′ ions. No gas evolution or inflection point is observed with anodes of mercury or silver except at high-current densities with small anodes when the surface becomes completely coated with films. J. N. P.

1723. *Electrolysis of Acid Solutions of Copper Sulphate. II. Constant Currents.* **J. T. Burt-Gerrans.** (J. Phys. Chem. 30. pp. 396–413, March, 1926.)—Experiments on the electrolysis at 18° C. of acid solutions of $CuSO_4$ with constant current are carried out with a view to determining whether the want of sharper agreement between certain predictions of the mathematical theory of changes of concentration at the electrode and the behaviour of such solutions on electrolysis is due to inaccuracy in the fundamental assumption of the theory, or to insufficient experimental approximation to the ideal conditions postulated by the equations [see Abstract 903 (1926)]. Apparatus and circuits for recording the p.d. over an electrolytic cell during the first second or so of an electrolysis, and for calibrating the oscillograph record with respect to time and voltage are described. The results obtained are shown to agree with theory within the limits of experimental error, both with the revolving kathode and between flat Cu electrodes. The effect of unequal friction between the electrolyte and different parts of the same revolving kathode surface is discussed, and evidence is adduced that errors from this source are avoided in the apparatus employed. A. B. C. L.

1724. *Electro-chemical Behaviour of Chromium. Part I.* **G. Grube, R. Heidinger** and **L. Schlecht.** (Zeits. Elektrochem. 32. pp. 70–79, Feb., 1926.)—The behaviour of chromium as anode was followed by means of the current density—potential curves in sulphuric and hydrochloric acids, and in solutions of sodium chloride and potassium hydrate. The results indicate that at low current densities chromium passes into solution in these electrolytes in the divalent form. A secondary change takes place with a chromium anode in sulphuric and hydrochloric acids, and in cold sodium chloride and potassium hydrate solutions, resulting in the formation of chromic acid and chromates. In a hot solution of sodium chloride, at low current densities, divalent chromium salts which are first formed are oxidised to trivalent salts or to chromic acid. In all cases the current density potential curves fall into two steps which are separated by more than one volt, the first step corresponding to the passage of active chromium into divalent ions, and the second to the oxidation of the divalent ions into trivalent ions. In alkaline solution chromium becomes passive, most probably due to the formation of an oxide layer. In acid solution no evidence of the existence of such a layer could be obtained. F. J. B.

1725. *Electro-chemical Behaviour of Chromium. Part II.* **G. Grube** and **L. Schlecht.** (Zeits. Elektrochem. 32. pp. 178–186, April, 1926.)—Continuing the work published in an earlier paper [see preceding Abstract], the authors have investigated the equilibrium potentials of chromium in a solution of divalent chromium ions and of the divalent and trivalent chromium ions. The results obtained show that the equilibrium potential of an active chromium electrode in a practically neutral solution of chromous sulphate, which is 1·138 normal, is − 0·581 volt. The normal potential Cr/Cr^{++} is − 0·55 volt. The equilibrium potential Cr^{++}/Cr^{+++} was found to be 0·403, 0·003 volt in a neutral solution of chromium acetate containing 0·02 gramme-atom of chromium per litre, and for divalent and trivalent chromium in the ratio of 1 : 1. In 0·0003*n* sulphuric acid sulphate solution containing 0·1 to 0·3 gramme-atom of chromium per litre, and $Cr^{++} : Cr^{+++}$ 1 : 1, the potential is −0·412 ± 0·002 volt, and in feebly acid chloride solution, 0·4 gramme-atom chromium per litre, and $Cr^{++} : Cr^{+++}$ 1 : 1, the potential is − 0·454 ± 0·002. If this solution was diluted to 0·02 gramme-atom of chromium per litre the potential became 0·398 ± 001 volt. The potential Cr^{++}/Cr^{+++} in chloride solution is dependent on the concentration of the chromium. F. J. B.

1726. *Preparation of Colloidal Silver by Electrolysis.* **A. Lottermoser** and **S. Bausch.** (Zeits. Elektrochem. 32. pp. 87–92, Feb., 1926.)—Since all chemical reductions at suitable concentrations yield silver in the colloidal state, electrolysis should also give colloidal silver, though the germ formation would in this case be restricted to the kathode surface and would not be general throughout the solution. Repeating the electrolytic experiments of Billitzer of 1902, and others under varied conditions, the authors find that the product is a colloidal silver oxide and not colloidal silver, which may, however, be formed by secondary reactions. Gelatin reduces the oxide to colloidal silver when the silver solution is exposed to light. Alternating currents with silver electrodes in caustic soda or sodium silicate may yield a sol owing to a Wehnelt effect, and even direct currents may give silver peroxide at the anode, which is partly reduced then by the kathodic hydrogen. H. B.

1727. *Electrolytic Separation of Metals.* **D. J. Brown.** (Am. Chem. Soc., J. 48. pp. 582–583, March, 1926.)—Sand [Abstract 932 (1907)] introduced an auxiliary mercury sulphate electrode for grading the potential at which a metal is to be deposited. The author replaces this auxiliary electrode by a wire of the metal to be deposited, which is connected in the way proposed by Schoch and Brown [Abstract 1372 (1913)]. When no wire of the metal is available, a wire of platinum, or, in the case of tin, of copper is connected in parallel with the kathode, and the current is broken a moment before the wire is to be used as auxiliary electrode. The examples given concern Cu, Bi, Sb, Sn. H. B.

1728. *Direct Oxidation of Manganous Ion to Permanganate.* **A. N. Campbell.** (Faraday Soc., Trans. 22. pp. 46–51, Jan., 1926.)—Allmand and Campbell [Abstract 1278 (1925)] observed that the saturated ammonium sulphate in the anode pot became pink during the electrodeposition of magnanese, suggesting diffusion of the manganous sulphate from the kathode compartment into the anolyte and oxidation of the manganous ion into permanganate, even at very low manganese concentration. The author investigates the optimum conditions of this permanganate formation, which does not appear to promise any analytical or technical application. H. B.

1729. *Influence of Alternating Currents on the Electrolytic Corrosion of Iron.* **A. J. Allmand** and **R. H. D. Barklie.** (Faraday Soc., Trans. 22. pp. 34–44; Disc., 44–45, Jan., 1926. El. Rev. 98. pp. 637–638, April 16, 1926. Abstract.)—The authors summarise the literature on the subject and describe experiments with direct current on iron anodes in caustic soda, on iron electrodes polarised by alternating current in caustic soda, on the effect of superposed alternating current on iron anodes in alkaline solutions and on soil liquids saturated with CO_2. It is found that the superposition of the two types of currents causes relatively increased corrosion, and that this also applies to iron exposed to typical subsoil drainage liquid saturated with CO_2. The corrosion was the greater the higher the ratio of the alternating to the direct current, the higher the current density and the lower the frequency; various frequencies between 6·4 and 400 were tried. H. B.

1730. *Nitrogen Fixation by Barium Carbonate and Carbon in an Electric Furnace.* **A. Schweitzer.** (Zeits. Elektrochem. 32. pp. 98–105, Feb., 1926.)—In a technical process for the fixation of nitrogen by a mixture of barium carbonate and carbon the mixed substances containing an excess of carbon are finely ground, compressed with a small amount of pitch to cylindrical blocks, and subjected to a coking treatment by preliminary heating whereby the barium carbonate is mostly converted into oxide and the material remains as a porous mass possessing an adequate electrical conductivity. The "barium-coke" is then passed down the shaft of an electric furnace in a central constricted zone, of which graphite electrodes are mounted transversely and opposite each other. The barium-coke forms the current path between the electrodes, and is raised to the reaction temperature of 1300° to 1350° C. A stream of nitrogen is admitted from below, and, after being preheated by traversing the furnace product, passes through the reaction space and reacts with the mixture to give barium cyanide and cyanamide with evolution of carbon monoxide. The furnace product is withdrawn from the bottom in its original briquette form. The barium cyanide can be extracted or treated together with the cyanamide in an autoclave with steam to give ammonia. The residual barium carbonate and carbon are again employed as the starting-point for a further preparation. The proportion of cyanide to cyanamide nitrogen in the product is about 3 : 1. The optimum amount of carbon to be added to the barium carbonate is found to be about twice that demanded by theory for the formation of $Ba(CN)_2$, or of $BaCN_2 + C$. With a furnace unit of 30 kw. capacity, having an output of 33 kg. per hour, the energy consumption for 1 kg. of fixed nitrogen amounts to 19·7 kw.-hr. With a more efficiently constructed plant it is considered that this should be reduced to 8 kw.-hr., which compares with values of 60 kw.-hr. for arc processes and 16 kw.-hr. for the calcium cyanamide process. J. N. P.